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THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 50 JANUARY, 1933 No. 1

EDIBLE MOLLUSKS OF MANILA

By FLORENCIO TALAVERA and LEOPOLDO A. FAUSTINO

Of the Bureau of Science, Manila

EIGHTEEN PLATES AND SIX TEXT FIGURES

The Philippine Islands has furnished the different museums of the world with a great variety of marine, fresh-water, and land shells. As a matter of fact, there are few places in the world that can rival the Philippines as a shell locality. While Philippine shells as ornaments and as objects of beauty and scientific investigations are known the world over and have been the subject of papers and monographs, the food value of the soft parts has not been very seriously studied. As a preliminary to a more-detailed study of the habits, ecology, and life histories of the different shellfishes used as food with a view of promoting the shellfish industries there are here presented records of all the species of shells sold and used as food in and around Manila during the last four years, with notes on their occurrence, habitats, habits, culture, and uses as food. Most of these were actually purchased in various Manila markets; namely, Divisoria, Quinta, Sampaloc, and others, or from street vendors in the more thickly populated districts. The shells are presented in the order of their importance by families and not by following the usual systematic scheme of classification. Practically all these mollusks are sold in their shells, and the shells are the means of identifying them; therefore, a description of the shell is given for each species. As aid to the identification of the shells figs. 1, 2, 3, and 4 give the names of the different parts of the shells.

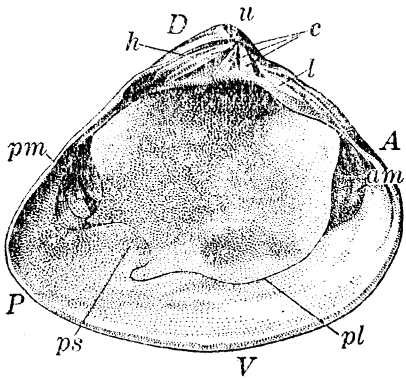


FIG. 1. *Meretrix meretrix* Linnæus, left valve; *A*, anterior end; *P*, posterior end; *D*, dorsal margin; *V*, ventral margin; *AP*, length of shell; *VD*, height of shell; *h*, ligament, or hinge line; *u*, beak, or umbo; *c*, hinge, or cardinal teeth; *l*, lateral tooth; *am*, anterior adductor muscle scar; *pm*, posterior adductor muscle scar; *pl*, pallial line; *ps*, pallial sinus.

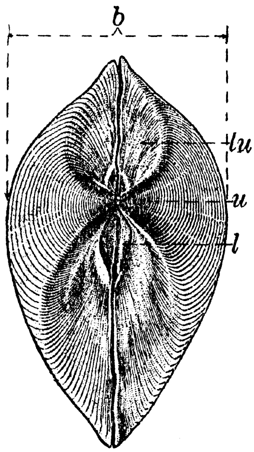


FIG. 3. *Meretrix meretrix* Linnæus; *b*, breadth; *lu*, lunule; *u*, umbo; *l*, ligament area.

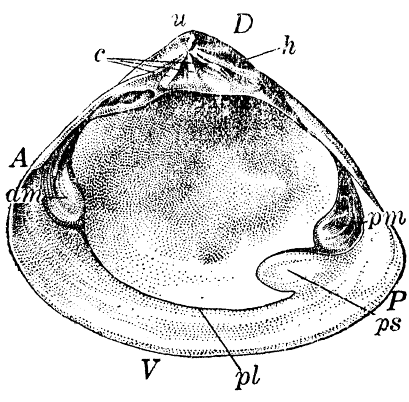


FIG. 2. *Meretrix meretrix* Linnæus, right valve; lettering the same as in fig. 1.

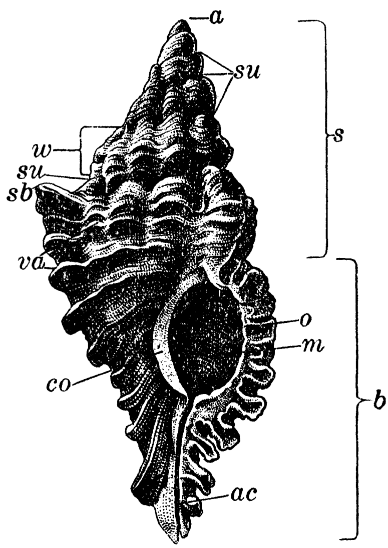


FIG. 4. *Murex torrefactus* Sowerby, young; *a*, apex; *s*, spire; *m*, mouth, or aperture; *o*, outer lip; *ac*, anterior canal; *co*, columella; *va*, varix; *su*, suture; *b*, body whorl; *sb*, shoulder of whorl.

The list of the species considered includes those of all the classes of Mollusca excepting the Cephalopoda. In other words only those with the shells external are taken into account. One species of Brachiopoda is included.

Summary list of the species of mollusks represented in the order of their importance.

Ostrea iredalei Faustino.
Ostrea malabonensis Faustino.
Ostrea palmipes Sowerby.
Arca cepoides Reeve.
Arca binakayanensis Faustino.
Arca antiquata Linnæus.
Arca chalcanthum Reeve.
Arca cornea Reeve.
Arca inæquivalvis Bruguière.
Paphia hiantina Lamarck.
Paphia ferruginea Reeve.
Paphia striata Chemnitz.
Paphia turgida Lamarck.
Circe pectinata Linnæus.
Circe gibba Lamarck.
Circe divaricata Chemnitz.
Circe scripta Linnæus.
Venus (Anomalocardia) squamosa Linnæus.
Venus (Anaitis) alta Sowerby, jr.
Mactra mera Deshayes.
Macoma pellucida Philippi.
Soletellina (Soletellina) cumingiana Deshayes.
Soletellina (Psammotæa) elongata Lamarck.
Soletellina (Psammotæa) minor Deshayes.
Mytilus smaragdinus Chemnitz.
Modiolus philippinarum Hanley.
Modiolus metcalfei Hanley.
Pharella acutidens Broderip and Sowerby.
Anatina truncata Lamarck.
Donax radians Lamarck.
Hemidonax donaciforme Schroeter.
Cyrena ventricosa Deshayes.
Corbicula fluminea Müller.
Dalliella subcrassa Lea.
Strombus canarium Linnæus.
Melongena pugilina Born.
Melongena galeodes Lamarck.
Potamides (Telescopium) telescopium Linnæus.
Potamides (Cerithidea) rhizoporarum A. Adams.
Potamides (Terebralia) sulcatus Born.
Umbonium vestiarium Linnæus.
Pila luzonica Reeve.
Vivipara burroughiana Lea.
Thiara asperata Lamarck.
Lingula unguis Linnæus.

OYSTERS

OSTREIDÆ

Other names.—Edible oysters, rock oysters, backwater or mud oysters.

Vernacular names.—Talaba, talabáng talím, "chinelas," kukóng kabayo, pulídpulíd, butíl (Tag.); talaba, sisí (Vis.); tirem (Il.).

OCCURRENCE, HABITAT, AND HABITS

Around Manila Bay three species of oysters of economic importance are found in abundance in shallow water, in estuaries, tideflats, swamps, and fishponds, where they are either exposed or submerged a few feet below the surface during the low tide. The tidal conditions and the temperature of the water are both favorable for the growth and proper development of the oysters. According to the United States Geodetic Survey, for Manila

"the greatest range of tide occurs usually in June and December and the smallest range in March and September."[1] The surface temperature of the water in Manila Bay ranges from 24° to 29° C. during the year.[2] Numerous streams discharge their waters into Manila Bay. The largest of these is Pampanga River and its distributaries. The shores of Manila Bay, therefore, receive a good quantity of fresh water, particularly in times of flood and during the rainy season.

Oysters thrive best in water which is neither too salty nor too fresh; that is, where there is a range of salinity represented by variations in specific gravity from 1.010 to 1.025; and whenever the specific gravity of the medium is below 1.010 they greatly suffer; if it continuously falls below 1.007 they either die or become unusable.[3] Likewise, whenever the specific gravity rises above the normal limit they succumb or become useless as breeders. In other words, extreme freshening resulting from too much freshet from the land and streams usually during and after a heavy rainfall, or extraordinary salting of the water due to rapid evaporation during dry warm weather is apt to affect them with disastrous results.

The oysters feed by straining out minute organisms and dissolved animal and vegetable matter from the water which is drawn in by means of the vibrating movement of the fine hairs covering the gills. Salt- or brackish-water diatoms, animal plankton, and finely divided miscellaneous substances are the principal food constituents the oysters obtain from the sea by a sort of filtration. They feed a large part of the time, filtering or drawing in many gallons of water a day. As long as they are breathing the food particles continuously roll or slide along the gills toward the mouth, which is located at the narrow front end of the animal.

However, the feeding activity is hampered by organic slimes and much silt. Large amounts of suspended organic and inorganic matter may suffocate both the adult and the young. While in the swimming stage the attachment of the young is made difficult by the silting of the bottom or any hard object upon which they chance to land; and even after they have

[1] U. S. Coast Pilot, Philippine Islands, pt. 1 (1927) 53.

[2] Selga, Rev. Miguel, Sea Surface Temperatures in the Philippines, Publ. Manila Observatory 3 No. 3 (1932).

[3] Tressler, Donald K., Marine Products of Commerce. The Chemical Catalog Co., New York (1923), Chap. 27, the World's Oyster Industry.

gained anchorage, their feeding and breathing processes which are carried on simultaneously are greatly hindered by sedimentation.

Oysters have a short free-moving life. During the early stage the larvæ are hairy and swim for some days on the upper level of the water drifting along with the tidal currents. Obviously their life during this period is the most precarious. In time the roving creatures, which are easily affected by sudden changes in environment, lose their buoyancy due to the increasing weight of the growing shell. They have then reached the shelled larval or spat stage, the beginning of their sedentary life. Those that survive the adverse condition settle down or set, attaching themselves to any hard object they may chance to fall upon. The horizontal and vertical distribution of the "settlers," also known as "set" or "spat," is influenced by the current velocity of the sea water, waves, natural enemies, and other factors. The spat falling on favorable places in due time develop into "seed oysters" or simply "seeds," which may be collected for transplantation or left where they have settled to grow until harvested.

CULTIVATION

Methods of collecting spat.—In order to initiate a new growth of oysters, a start may be made either with the spat or with the seed oysters. For catching the shelled larvæ various artificial devices are used in different countries, of which the commonest are the fascine collectors made up of brush or bundles of sticks or bamboo branches; bamboo screens; stakes or poles; limed semicylindrical tiles; rectangular wooden plates with thin friable coating of cement or lime mortar; wire crates or cylindrical wire bags containing dead shells of oysters, scallops, or clams; oyster shells threaded on wires which are hung from strands of wire stretched between posts or suspended from rafts or floats; tarred cables or ropes suspended from floats or from ropes running from post to post set into the bottom; and various empty shells and rough stones scattered over the grounds. The United States Bureau of Fisheries has recently introduced an improved method for the collection of spat, which is known as the partition type,[4] consisting of interlocking strips of waterproof cardboard coated with a mixture of cement, sand, and quicklime. This collector is cheap, practicable, suitable for

[4] U. S. Bur. Fisheries Document 1076 (1930).

stacking and collecting of spat, and especially for their separation soon after attachment.

Local cultural methods.—Fascine collectors are rarely if ever utilized in the oyster farms around Manila Bay. In Parañaque, Rizal Province, oyster spat are collected and grown on bamboo rafts; in Kawit, Cavite Province, and Abucay, Bataan Province, they are grown on bamboo stakes, or *tulus,* which are set in rows in the intertidal areas generally during May and June and removed usually after a year when the oysters are harvested. In Navotas and Malabon, Rizal Province, and Obando and Binuangan, Bulacan Province, where the cultivation of oysters is more or less extensive, the method used consists in scattering empty oyster shells on the grounds where oysters are known to spawn and set. Spreading of shells, or cultching, is done from April to October, since the setting of oysters in the region takes place during this period. The cultch or collectors are loaded in bancas from which they are shovelled and scattered indiscriminately over the grounds. The sown shells are known locally as "binhi," meaning seeds, because of the mistaken common belief among the local oystermen that from these "planted" dead shells the young oysters develop. Since the scattered collectors are always exposed to the mercy of the tides, currents, and waves, a great many of them are buried or carried away with the result that they are apt to pile in heaps at certain places, leaving various patches almost if not entirely bare and devoid of cultch. In the oyster farms near Manila such occurrences are unavoidably common, resulting in small harvest or less profit and oftentimes in total loss to the oystermen. Losses through these causes may be minimized if the seed oysters are transplanted to grounds less exposed to unfavorable conditions. In the transplantation or cultivation of oysters several factors need consideration. It is necessary to consider carefully the nature of the bottom. It should not be so soft as to permit the shells to sink and suffocate, and it should not have shifting sand which will cover and smother them. A bottom with much decomposing organic material is unsuitable, as it may generate poisonous gases in sufficient quantity to be harmful. A moderately stiff or fairly hard sticky mud bottom is the most desirable. Oysters thrive well on a rocky bottom, but the harvesting of the crop from such a bed is always a problem. Oyster farms

should be in sheltered places, away from heavy seas and river currents, and in water not too deep for practical working.

Modern cultural methods.—The introduction of modern cultural methods would be of practical value and would increase the yield of the local industry considerably. The Chinese and Japanese in Formosa use a unique method which consists of dead oyster shells impaled on bamboo stakes three to four feet in length. Each stake carries from five to ten shells arranged at intervals on the upper portion so that the device is nothing but a long stem with a flowerlike crown of shells. The stakes are planted on the tideflats and the young oysters set on the impaled shells and are allowed to grow thereon until harvested. The Formosans also make use of empty oyster shells threaded on short wires which are suspended from long cables stretched between posts. This system of oyster culture is known as the "hanging method," which is based upon the idea of the "suspended ostreiculture" of the Romans. In Japan it has been extensively utilized to catch spat and grow seeds as well as to fatten adult oysters. The Japanese, however, have found through continuous experiments that a good-sized wooden raft supported on air-tight barrels is a more practical framework than a long line of posts from which to hang short wires carrying shell collectors or ropes. This innovation is now in use in many places in Japan, particularly at Kanazawa and Aburatsubu Bay in Misaki where one of us has observed such rafts for oyster culture.

It has been reported that oysters grown in this manner are not only fattened but also grow large with extreme rapidity.[5] Obviously, the method has distinct advantages since the three dimensions of space in the water may be utilized and because the growing oysters can be easily moved from one place to another as local conditions change, thus insuring more-successful cultivation and a cleaner food product with the least possible contamination.

The feasibility of this system of oyster culture has long been recognized in the United States; however, the method was only recently introduced in California. At Elkhorn Slough near Moss Landing, Watsonville, there is at present an extensive

[5] Journ. Imperial Fisheries Inst. 22 No. 4 (1927).

oyster farm under the supervision of a Japanese expert. Imported Japanese seed oysters grown on ropes are used. The ropes, cut to desired lengths, are suspended at regular intervals from well-constructed wooden floats. The culture has been very successful according to a recent report.[6]

Harvesting and marketing.—In Navotas, Malabon, and Obando, particularly, the fishermen simply dive for the shells and gather them from the bottom with bare hands which are protected only by a wrapping of old rags. Each diver carries a wire basket to hold the catch which is from time to time transferred into a waiting banca. No dredge, scraper, tongs, nippers, or similar implements that can be worked from a banca are in any way employed to collect oysters in these localities. The cultivated grounds are harvested every year, but since it is impossible to gather all the oysters on a farm at any one time, the yield generally consists of shells from one to three years old or older. A load of oysters in a banca 6 meters long, 60 centimeters wide, and about 40 centimeters deep, is worth around 5 pesos at the farms. Most of the crop is marketed in Manila, where the raw mollusks bring from 40 to 80 centavos a hundred. Oysters are sold in the shell or shucked; the shucked meats are usually retailed in cupfuls from earthen jars (palyok), tin or wooden pails, or in heapings placed on banana leaves on the market table. A liter of fresh shucked oysters sells for about 40 centavos at the cultural centers and around 60 centavos in Manila.[7]

In places where the tulus method is used the crop is harvested a year after the placing of the stakes. These are removed or pulled out from the bottom and the attached oysters are chipped off. The yield which consists chiefly of the thin curved oysters is sold at a very much lower price.

From the rock walls of the breakwater at Fort San Antonio Abad oysters are gathered daily by naked divers using a pry, which may be an old bolo, file, or iron rod with which to detach the oysters from the rocks and a pair of water-tight goggles to protect their eyes while locating the mollusks. The oysters obtained here are the kinds that grow to a large size. These are sold at from 40 to 60 centavos a hundred at the premises and for more at the markets where they are in demand because of the

[6] Calif. Fish and Game 17 No. 3 (1931).

[7] One peso, or 100 centavos, Philippine currency equals 50 cents United States currency.

fact that they are obtained from a much cleaner ground than the other oyster farms around Manila.

Oysters can be kept or transported in the fresh state for comparatively long periods, if properly packed in baskets, boxes, or barrels with sufficient seaweed to keep them moist. They stand removal from the water with remarkable endurance due to their surprising ability to hold the shells tightly closed for a long time. This remarkable power to live out of water for several days is explained by the fact that under normal conditions oysters in shallow water are subjected to daily exposure to sun and air during low tide, and this has undoubtedly brought about in the shellfish this adaptability. Endurance tests conducted with local species under normal laboratory room temperatures obtaining during March, April, and May in Manila (21° C. to 34.9° C.), have shown that *Ostrea iredalei* Faustino can live out of water for six days; *Ostrea malabonensis* Faustino for about five days; and *Ostrea palmipes* Sowerby for about three days.

Status of fisheries.—The farms in Navotas and Malabon are worked by private individuals, who apparently pay no municipal fees for the more or less exclusive privilege they enjoy. The oyster grounds in Obando, Bulacan, and Binakayan, Kawit, are run on the lease system. Plats are leased to tenants by the municipality, and the lessees are amply protected. Oysters are not taken from leased grounds any more than rice is taken from a man's rice field. There are, however, natural oyster beds in many places around Manila Bay that are being utilized as public fisheries; that is, where oysters are gathered without permit of any kind.

UTILIZATION

Philippine oysters are extensively used as food. Because of their excellent flavor they are always appetizing when eaten raw. All the soft parts are edible. Great quantities of fresh oysters find their way into the "panciterias," or Chinese restaurants, where they are prepared in various tasty dishes. Considerable amounts are also used by Filipino food vendors and housewives in the making of a number of Filipino dishes sufficiently tempting to even the most fastidious epicures. The simplest and commonest way of preparing oysters for the table is to steam them open in the shell; the meat is extracted and eaten plain or with a vinegar sauce. Another way is to shuck fresh oysters and pickle the raw meat in vinegar seasoned with

onion, salt, and pepper. Oysters are also pickled in salt and bottled.

In the vicinity of oyster farms and in places where the mollusks are shucked there are piles of old shells. These are utilized primarily for cultching and for the manufacture of lime.

DESCRIPTION OF THE SPECIES

The commonest species of oysters encountered in Manila Bay are *Ostrea iredalei* Faustino, *Ostrea malabonensis* Faustino, and *Ostrea palmipes* Sowerby. *Ostrea iredalei* Faustino is the largest of the three species and is easily recognized by the chalky white interior and the purple muscle scar. The other two are small but have a delicate flavor. They are the ones to which the local name "pulidpulid" or "butil" is applied. *Ostrea palmipes* Sowerby is rather thin but fairly marketable. *Ostrea palmipes* may be distinguished from *Ostrea malabonensis* by the fact that the lower valve of the former has the appearance of a webbed foot of a bird while the lower valve of the latter has the appearance of a horse's hoof.

OSTREA IREDALEI Faustino. Plate 1, figs. 1 and 2; Plate 2, figs. 1 to 3.

The shell is somewhat variable in shape depending largely upon the object and mode of attachment. Those growing in bunches are elongate, sometimes tongue-shaped, sometimes obliquely triangular, and sometimes oblong. The exterior of the shell is very foliaceous, and the beak is prominent.

The lower, or left, valve is slightly excavated and generally has a purple tint. The upper valve is smaller, thinner, flatter, generally yellowish brown, sometimes with faint radiating rays of purple, covered with thin laminæ, and scaly at the margins.

The hinge is toothless, and the valve margins inside are smooth. The interior of the shell is chalky white, and the muscle scar is purple.

Length, 30 to 80 millimeters.

OSTREA MALABONENSIS Faustino. Plate 1, figs. 3 to 6; Plate 3, fig. 4.

The shell is not large, in some cases roughly triangular in shape, in others irregularly oblong, and is solid. This species is not usually found in clusters, but is generally attached singly to other shells.

The lower valve is concave, deep, and plaited. The plaits are rounded, large, and numerous. The upper valve is plain though sometimes it is also plaited at the margin.

The interior of the shell has greenish brown spots, and the valve margins near the hinge are toothed.

Length, 25 to 45 millimeters.

OSTREA PALMIPES Sowerby. Plate 3, figs. 1 to 3.

The shell is thin and is much compressed. The shape is more or less square with rounded corners. Generally the shells are flat but when attached to a rounded surface like the surface of bamboo poles they become concave.

The lower valve is expanded beyond the upper and is radiately ribbed; the ribs are tuberculated. The upper valve is smooth, smaller, and obscurely rayed. The interior of the shell is greenish brown, and the valve margins near the hinge are toothed.

Length, 40 to 60 millimeters.

ARK SHELLS

ARCIDÆ

Other names.—Chest shells, blood clams, rock cockles, arcas.

Vernacular names.—Halaan, halaan lalake, bototoy, litob, litog, bilogan, bígatan (Tag.); litog, suliut, balisá, bakalan (Vis.).

OCCURRENCE, HABITAT, AND HABITS

More than forty species of ark shells are found in the Philippines, occurring in bays or exposed beaches with sandy or muddy bottom and on reefs and among rocks in shallow water. In Manila Bay no less than six species are found along the shores of Pasay, Parañaque, Binakayan, and Kawit where the most important natural beds exist; they also occur along the northern and western shores of Manila Bay, from Navotas, Rizal Province, to Balanga, Bataan Province.

These mollusks are active shallow burrowing bivalves and have a strong elongated foot but no siphon tube; they are primarily vegetarians, subsisting upon microscopic plants from the water drawn in and out through the holes that are formed by the fusion of the mantle margins at two points. They are very prolific; the fry after quitting the free-swimming stage tend to settle in definite areas in great quantities. Apparently, in Manila Bay they spawn continuously throughout the year. At Parañaque small and large ark shells are noticeably abundant during April, May, and June, which would seem to indicate that the height of the spawning period of the clams in this locality is probably during December and January. Although their rate of growth is not definitely known, it is believed

that under the local conditions the arcas may attain a marketable size in less than two years.

METHOD OF COLLECTION

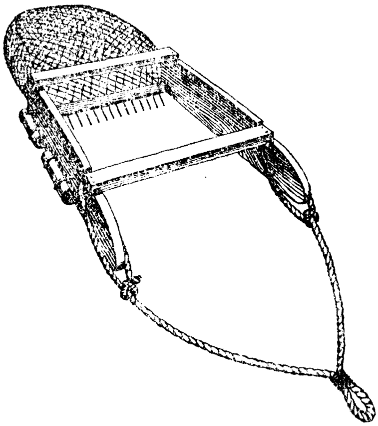


FIG. 5. The kulakud.

At Pasay, Parañaque, and Binakayan, where fishing for arcas is an industry of considerable importance, the native fishermen use a number of collecting devices. One of these is the crude but unique *kulakud* (fig. 5), which consists of a pair of wooden rectangular skids, each about 70 centimeters wide and 2 centimeters thick, and a bag net attached behind the boards. The lower frame of the mouth carries a number of perpendicularly directed iron teeth serving as rakes. Iron weights are tied to the outer side of each board in order to increase the weight of the implement. To the forward ends of the skids a rope about 2 meters long is attached to make a bridle to which the pull rope is tied. The kulakud is operated in water about 5 meters deep by two men from a banca with an outrigger on one side only. The implement is carefully lowered into the water so that on landing the rakes rest on the ground; the banca is taken to a distance of about 30 meters and there held fast to a bamboo pole well driven into the bottom; then the pull rope is hauled in, and the catch after being washed of dirt is emptied into the banca. Another implement used is the long-handled rake dredge, the *pañgahig* (fig. 6), which is

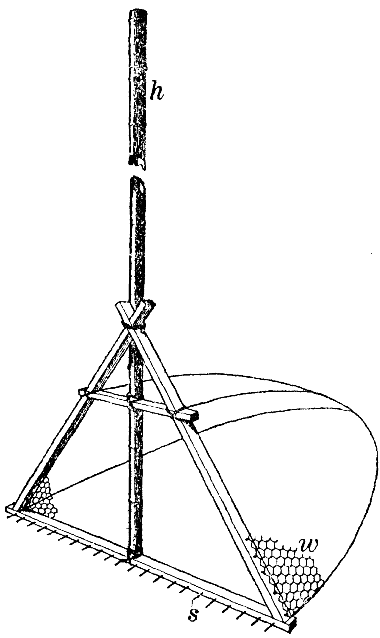


FIG. 6. The pañgahig; *h*, handle; *s*, iron nails; *w*, wire netting.

worked by one man from a banca. A triangular dredge sieve made up of bamboo splints is also used. On the exposed areas during low tide arcas are collected by sifting the ground with the fingers.

UTILIZATION

The abundance of empty ark shells near seashore homes around Manila Bay is evidence that the mollusks are extensively used as food. The clams are gathered alive and prepared for the table in various ways. They are generally steamed open in the shell with slices of ginger root to flavor the resulting juice or broth; the steamed meats are eaten plain or seasoned with some sauce. The fresh arcas are also shucked and the raw meats are used as a basis for some native dishes, or pickled in vinegar and bottled. In the public markets fresh blood clams sell for from 10 to 50 centavos a hundred, depending upon the size. The empty shells are utilized in the manufacture of lime. In Parañaque there is a lime factory that uses great quantities of arcas.

DESCRIPTION OF THE SPECIES

Of the species sold in the markets and used as food the commonest are *Arca cepoides* Reeve, *Arca binakayanensis* Faustino, and *Arca antiquata* Linnæus. *Arca inæquivalvis* Bruguière is the largest species encountered. *Arca antiquata* Linnæus, *Arca chalcanthum* Reeve, and *Arca cornea* Reeve are found occasionally.

ARCA CEPOIDES Reeve. Plate 7, figs. 5 and 6.

The shell is somewhat squarely egg-shaped, thin, and inequivalved. The sides are angulated at the upper part, the anterior end is somewhat rounded, and the posterior end is a right angle. The exterior is white and is covered with a thin brown epidermis, which is scaly between the ribs. The ribs radiate from the umbo, are 31 to 33 in number, and are smooth and flat. There are a few on the left valve that are somewhat broader than those on the right valve.

Length, 42 to 45 millimeters; height, 38 to 40; breadth, 28 to 32.

ARCA BINAKAYANENSIS Faustino. Plate 7, figs. 3 and 4.

The shell is nearly square, thick, and inequivalved. The left valve extends beyond the right valve. The sides are angulated at the upper part, the anterior end is somewhat rounded,

and the posterior is almost a right angle. The exterior is white and is covered with a thin brown scaly epidermis, which comes off easily. It is radiately ribbed. On several specimens there are 34 ribs. The ribs are flat and fairly smooth. A few on the left valve are somewhat larger than those on the right valve.

Length, 45 to 55 millimeters; height, 40 to 50; breadth, 33 to 38.

ARCA ANTIQUATA Linnæus. Plate 7, figs. 1 and 2.

The shell is obliquely heart-shaped, thick, and rather gibbous. It is equivalved with the sides angulated at the upper part. The anterior end is somewhat rounded and short, and the posterior end is obtusely extended. The exterior is whitish, is coated with a brown hairy epidermis, and is radiately ribbed. The ribs number 30, are comparatively narrow, and are sharp-edged. They are nodulously decorated toward the umbo. The inside is white and is marked with numerous shallow radiating grooves.

Length, 44 to 50 millimeters; height, 34 to 39; breadth, 30 to 36.

ARCA CHALCANTHUM Reeve. Plate 8, figs. 1 and 2.

The shell is oblong, somewhat compressed, and inequivalved. The sides are angulated at the upper part, the anterior end is short and rounded, and the posterior end is longer and much compressed. The exterior is whitish and is covered with a green horny cuticle, over which is a hairy brown epidermis. It is radiately ribbed, the ribs number 28; the inside is bluish white and is marked with numerous radiating grooves.

Length, 33 to 38 millimeters; height, 21 to 23; breadth, 15 to 17.

ARCA CORNEA Reeve. Plate 8, figs. 3 and 4.

The shell is somewhat square, rather gibbous, and inequivalved. The anterior end is short and rounded, but the posterior end is longer and is slightly obtusely angled. The exterior is whitish and is covered with a green horny cuticle, over which is a scaly brown epidermis. It is radiately ribbed, and the ribs number 29. The ribs on the right valve are flat and smooth; those on the left valve are nodulously decorated.

Length, 25 to 30 millimeters; height, 19 to 25; breadth, 16 to 20.

ARCA INÆQUIVALVIS Bruguière. Plate 8, figs. 5 and 6.

This shell is large, elongately egg-shaped, and inequivalved. The sides are angulated at the upper part, the anterior end is short, and the posterior end is obtusely angled. The exterior is whitish and is covered with a thin brown epidermis, scaly between the ribs. It is radiately ribbed, and the ribs number 32 or 33. They are smooth, flat, and regular. The ligament area is rather narrow.

Length, 70 millimeters; height, 60; breadth, 50.

SAND CLAMS

VENERIDÆ

Other names.—For *Paphias,* surf clams, hard-shell clams, skimmers. For *Circes,* small clams, cockle clams, ridged sand clams. For *Venus,* Venus clams, waved sand clams.

Vernacular names.—For *Paphias,* halaan, halaan babae, kabiâ, punao, patayóg (Tag.); punao, paróng manók (Vis.). For *Circes,* bígatan, kalumismis, kamotpusâ, sarópsarópan, tambayáng babae (Tag.); búgatan (Vis.); daroparpar (Il.). For *Venus,* butíl, kanturî, moran (Tag.).

OCCURRENCE, HABITAT, AND HABITS

The Veneridæ include clams that are mainly littoral in occurrence and require a clean habitat and strong tidal current over the grounds where they live, so that they are usually found on open seashores and near the entrance to a lagoon or large stream where the tidal flow is great. Around Manila Bay the sand clams are limited to sandy shores or beaches that are exposed to the constant rushing and beating of the surf. They are found much scattered and do not grow in regular beds. The clams are constantly active. As the waves sweep the shore they try to gain a foothold by their large muscular foot, which enables them to work their way down to prevent being buried too deeply or dislodged and thrown to the mercy of the elements.

These actively burrowing bivalves have short siphons. The exhalent tube is shorter than the inhalent and is provided with a delicate thin-walled tip, rimmed with minute short projections. The opening is tightly closed when not in use, and when opened the entrance of sand is prevented by the outflowing current from the tube. The inhalent siphon has an enlarged

tip and terminates in a broad flat surface provided with an aperture that is closed by a delicate system of closely placed branched tentacles, which strain off every bit of sand as the water containing oxygen and food passes to the mantle cavity.

METHOD OF COLLECTION

Under ordinary conditions the clams are located by feeling with the fingers or toes or with some hard implement. On undisturbed beaches their location may be recognized by tiny holes overlying the whole shell. The smaller forms are generally obtained by sifting the sand with the fingers. The sandy stretches of Balanga, Malabon, Navotas, Pasay, Parañaque, and Cavite are the principal grounds from which considerable amounts of these sand clams are gathered by the inhabitants living along the shores.

UTILIZATION

These clams are among the best and most liked of the food mollusks and are regularly marketed and extensively used. Every part of the meat is eaten. The flesh is prepared as various savory dishes; the variety, indeed, shows the high regard in which the clams are held. The preparatory operation is to steam the shells open and remove the flesh. The broth resulting from steamed clams is delicious. In the public markets the clams are sold alive; the larger forms bring from 10 to 20 centavos a hundred, the smaller ones much less.

DESCRIPTION OF THE SPECIES

The commonest species that are marketed in large numbers are *Paphia hiantina* Lamarck, *Paphia ferruginea* Reeve, *Circe pectinata* Linnæus, *Circe gibba* Lamarck, *Circe divaricata* Chemnitz, *Circe scripta* Linnæus, *Venus* (*Anomalocardia*) *squamosa* Linnæus, and *Venus* (*Anaitis*) *alta* Sowerby, jr. *Paphia striata* Chemnitz and *Paphia turgida* Lamarck are also sometimes encountered.

PAPHIA HIANTINA Lamarck. Plate 3, figs. 5 and 6.

The shell is somewhat squarely egg-shaped, with the posterior end obliquely truncated. The color is variable, sometimes light gray, other times reddish yellow or light yellow, with or without netted flamed markings radiating from the umbo. The shell is concentrically ridged; the ridges are somewhat flattened at the center but rather sharp toward the posterior

end. The interior of the shell is orange, but near the hinge the shell is pale blue.

Length, 53 millimeters; height, 42; breadth, 33. These measurements are for the larger shells. Smaller shells are also collected and sold in great numbers.

PAPHIA FERRUGINEA Reeve. Plate 4, figs. 1 to 5.

The shell is elongately egg-shaped, sometimes rather compressed. The color varies from light to reddish yellow. The exterior is characteristically wave-clouded with rust and is concentrically ridged. The ridges are rather irregular.

Length, 30 millimeters; height, 23; breadth, 16.

PAPHIA STRIATA Chemnitz. Plate 4, figs. 6 and 7.

The shell has its posterior end wavily tapering, and the anterior end is tumidly heart-shaped. The color is reddish yellow. The shell is concentrically ridged, the ridges sometimes confluent.

Length, 42 millimeters; height, 35; breadth, 24.

PAPHIA TURGIDA Lamarck. Plate 4, figs. 8 and 9.

The shell is somewhat squarely oblong with the posterior end obtusely angled. The color is light yellowish brown with dark brown spots marking the direction of rays from the umbo. The concentric fine ridges are sometimes confluent toward the posterior and anterior ends. The interior of the shell is orange yellow.

Length, 46 millimeters; height, 32; breadth, 18.

CIRCE PECTINATA Linnæus. Plate 5, figs. 3, 4, and 8.

The shell is elongately oval and compressed. It is whitish, and radiately ribbed; the ribs larger and farther apart at the middle; smaller, nearer each other, and more irregular toward the anterior end, sometimes bifurcating toward the ventral margin. They are nodosely grained, and the nodules are concentrically arranged. The posterior end is plaited, the plaits diverging widely.

Length, 37 millimeters; height, 31; breadth, 18.

CIRCE GIBBA Lamarck. Plate 5, figs. 1, 2, and 7.

The shell is elongately egg-shaped, gibbous, and whitish. It is radiately ribbed; the ribs are larger and farther apart at the middle; smaller, nearer each other, and more irregular toward the anterior end, sometimes bifurcating toward the ventral

margin. They are nodosely grained; the nodules are concentrically arranged, much smaller and closer together toward the margin. The posterior end is plaited, the plaits diverging widely.

Length, 35 millimeters; height, 31; breadth, 21.

CIRCE DIVARICATA Chemnitz. Plate 5, figs. 5 and 6.

The shell is elongately oval and rather gibbous. The exterior is reddish yellow to whitish, with reddish brown linear markings, which are interruptedly radiating. It is concentrically and irregularly ridged and also radiately ribbed with the crossings more or less conspicuously granulated. The ribs radiating from the umbo bifurcate or branch before reaching the ventral margin.

Length, 44 millimeters; height, 35; breadth, 24.

CIRCE SCRIPTA Linnæus. Plate 6, figs. 1 and 2.

The shell is somewhat squarely lens-shaped and compressed, with the posterior end obtusely angled. The exterior is reddish yellow to whitish and is linearly waved with dark brown markings. It is also sometimes biradiately blotched. It is concentrically ridged, the ridges fine and close together.

Length, 47 millimeters; height, 43; breadth, 16.

VENUS (ANOMALOCARDIA) SQUAMOSA Linnæus. Plate 6, figs. 5 and 6.

The shell is subtriangular and rather gibbous, more or less swelling out. The posterior end is wavily tapering. The color is whitish. The exterior is radiately ridged, the ridges close-set. The concentric undulations on the ridges simulate latticed sculpture. The margins are finely notched within. The lunule is large.

Length, 23 millimeters; height, 19; breadth, 15.

VENUS (ANAITIS) ALTA Sowerby, Jr. Plate 6 figs. 3 and 4.

The shell is obliquely subtriangular and thick. The exterior is whitish and broadly rayed with flesh purple. It is concentrically laminated, the laminæ are a little reflected and slightly produced, not so much raised in front and leaving a space between their terminations and the lunule. The ligament area is large and broadly excavated, and is deep violet-purple. The dorsal margin is slightly curved.

Length, 23 millimeters; height, 19; breadth, 14.

HEN CLAMS

MACTRIDÆ

Other names.—Mactrids, mactras, large surf clams, giant clams.

Vernacular names.—Katakao (Tag.); punao (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The mactrids inhabit sandy bottoms. Several species have been reported around Manila Bay, notably near Parañaque and Bacoor.

The hen clams are natural, active, shallow burrowers, living buried just below the surface of the sand, and are rather migratory in habit, moving up or down the shore in accordance with the direction of the current. They appear to remain at about the same position relative to sea-level on the shore all the year round; that is, about midway between half tide and extreme low tide. The clams can extend their foot to a distance of a few centimeters in search of food; they also use this organ for anchorage and locomotion as well.

METHOD OF COLLECTION

These mollusks are gathered at low tide; those buried in the sand are secured with the aid of some hard implement, such as an old bolo, with which the sand is scratched to locate them and with which they are dug out, one by one; those left exposed by the tide are simply picked up. A fork similar to that used for digging potatoes or a garden rake would be a very effective tool for getting them out.

UTILIZATION

The hen clams are extensively utilized as food. They are obtained alive from the natural beds at Parañaque, Bacoor, Navotas, and Malabon and are prepared for the table in very simple ways. They are steamed or parboiled in the shell, and the cooked meats are eaten plain or with some sauce, while the resulting juice is consumed as soup. Fresh clams are also shucked, and the raw meats are prepared as a basis for various dishes. Some epicures consider the hen clams, if nicely prepared, just as palatable as oysters. In the public markets the hen clams are sold in the shell for from 20 to 50 centavos a hundred. No fresh shucked hen clams are marketed.

DESCRIPTION OF THE SPECIES

Only one species is marketed in any quantity, and this is *Mactra mera* Deshayes (*Mactra antiquata* Reeve, non Spengler.)

MACTRA MERA Deshayes. Plate 6, figs. 7 and 8.

The shell is triangularly egg-shaped. It is inflated, equilateral, smooth, and shining. The color is generally rich purplish brown, finely white-rayed, deep violet at the umboes. The exterior is concentrically, densely, finely striated. The inside is smooth and violet. The sinus of the mantle is broad and rounded.

Length, 54 millimeters; height, 41; breadth, 25. Much larger shells are also encountered.

SUNSET AND MACOMA SHELLS

GARIIDÆ AND TELLINIDÆ

Other names.—Rayed shells, tellens.

Vernacular names.—Paros, parosparosan, tihim, sulib, karaniwan (Tag.); batitis, bayoyan (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The sunset shells inhabit sandy shores of open seacoasts and sheltered bays. Around Manila Bay they occur in more or less extensive beds on the intertidal areas in Bacoor Bay east of Cavite and around Bataan. They burrow just below the surface and are more or less stationary in habit. They are active diggers and have long, slender, and separate siphons, which are used both for food getting and for locomotion.

METHOD OF COLLECTION

The smaller shells are generally collected by simply sifting the ground with the fingers or by the use of a panlike dredge-sieve made of bamboo splints, with which to separate the clams from the sand. The larger shells generally burrow 20 or 30 centimeters below the surface. A small bamboo or wooden stick lowered into the hole is grasped by the shell so that it can be easily pulled out.

UTILIZATION

The sunset shells are among the most valued of bivalves and are used extensively for food by the Filipinos. When boiled or steamed in the shell they produce an excellent broth. They are shucked and the meat is prepared as soup or chowder.

A favorite method of preparing paros for the table is known in the vernacular as "sinobukan," which is made in this manner: Fresh paros bought in the market or gathered from the shore are washed and "floated" in a basin of water in order that they may free themselves of sand or dirt contained in their intestinal tract. As soon as they open their shells, boiling water is poured into the basin to kill and partially cook the animal. All the water is now drained off, care being taken not to separate the valves so as to provide a handle to each cooked clam. The diner now picks up a paros by its empty valve and before consuming it soaks the meat in vinegar sauce seasoned with salt, sometimes with finely chopped onions, a dash of white pepper, and a little salt.

In the public markets these mollusks are sold alive and bring from 10 to 15 centavos per kilogram.

DESCRIPTION OF THE SPECIES

The commonest species sold in the markets is *Soletellina* (*Psammotæa*) *elongata* Lamarck. *Soletellina* (*Psammotæa*) *minor* Deshayes, *Soletellina* (*Soletellina*) *cumingiana* Deshayes, all of the family Gariidæ, and *Macoma pellucida* Philippi, of the family Tellinidæ, are also gathered in quantities for home consumption. The suggestion has been made that *S. minor* is merely the young form of *S. elongata,* but our studies are not sufficiently advanced to warrant any definite conclusion.

SOLETELLINA (PSAMMOTÆA) ELONGATA Lamarck. Plate 10, figs. 4 and 5.

The shell is elongately transverse and rather gibbous. It is somewhat solid and more or less inequilateral. The exterior is purplish white, covered near the margin with a fibrous dark brown or yellowish brown epidermis. The shell is finely striated. The anterior end is shorter and slantingly rounded, while the posterior end is somewhat obtusely angled. The interior is characteristically deep violet.

Length, 71 millimeters; height, 37; breadth, 20.

SOLETELLINA (PSAMMOTÆA) MINOR Deshayea. Plate 9, figs. 6 and 7.

The shell is transversely egg-shaped and compressed. It is thin and nearly equilateral. The exterior is greenish yellow and obscurely rayed with violet. The anterior end is somewhat rounded, the posterior end is slightly drawn out. The interior is tinged with violet.

Length, 23 millimeters; height, 14; breadth, 7.

SOLETELLINA (SOLETELLINA) CUMINGIANA Deshayes. Plate 9, figs. 3 to 5.

The shell is elongately egg-shaped and slightly compressed. It is equilateral and concentrically striated. The exterior is purple-blue covered with a brownish epidermis. The anterior end is broader than the posterior end, which is slightly wavily impressed. It is inconspicuously two-rayed from the umbo. The interior varies from purple to purplish white.

Length, 72 millimeters; height, 35; breadth, 15.

MACOMA PELLUCIDA Philippi. Plate 9, figs. 1 and 2.

The shell is more or less egg-shaped, thin, and equally convex. It is glossy white, both within and without, is smooth, and has very fine concentric lines. The anterior end is rounded with the dorsal side convex and sloping. The posterior end has a small flexure and is also sloping. The ventral margin is slightly arched and is sloping upward posteriorly. The umboes are small, and the ligament area is small. The hinge margin is thin, and the teeth are minute.

Length, 18 millimeters; height, 15; breadth, 7.

SALT-WATER MUSSELS

MYTILIDÆ

Other names.—Sea or bay mussels, brown mussels, green mussels, weaving mussels, horse mussels.

Vernacular names.—Amahong, tahong, tehong (Tag.); tahong (Vis.); saytil (Il.).

OCCURRENCE, HABITAT, AND HABITS

The Mytilidæ are a large family of bivalved mollusks and include three principal groups or genera; namely, *Mytilus*, a world-wide gregarious genus of sea or bay mussels; *Modiolus*, or horse mussels; and *Lithophagus*, or rock eaters. All of these genera are represented in Manila Bay. The sea or bay mussels are found attached by means of the byssus to hard objects in more or less dense groups, in intertidal areas exposed to the washing of the surf; in fact, wherever there are ideal objects for attachment such as rocks or piles of wood or stones on the coasts or in bays, the sea or bay mussels are almost always to be found in large numbers; however, they do not thrive abundantly in quiet waters. The horse mussels occur singly and are generally encountered partially buried in mud or gravel. They get their nourishment by straining the detritus or dis-

solved organic matter from the water. The rock eaters make their homes in rocks which they riddle with vertical burrows. Their cylindrical shape and rough surface are peculiarities which bear directly upon their habits. In Manila Bay two species of *Modiolus* occur abundantly along the shores of Parañaque, Navotas, and Malabon; the green *Mytilus* are quite plentiful on the walls of the breakwater in front of Fort San Antonio Abad; however, the rock eaters are nowhere abundant in this bay.

UTILIZATION

The salt-water mussels can be cheaply collected and are extensively used as food. The meat is quite large and tender and has a characteristic flavor considered by some people as being superior to that of any other bivalve not excepting the edible oysters. The mussels are steamed or parboiled in the shell; they are also shucked and the raw meat is pickled in salt or vinegar and bottled. In the local markets fresh mussels in the shell bring from 5 to 10 centavos a dozen.

DESCRIPTION OF THE SPECIES

Three species are commonly found in the markets; namely, *Mytilus smaragdinus* Chemnitz, *Modiolus philippinarum* Hanley, and *Modiolus metcalfei* Hanley.

MYTILUS SMARAGDINUS Chemnitz. Plate 11, fig. 1; Plate 13, figs. 1 to 3.

The shell is subtriangular to elongately oblong in shape. The exterior is reddish brown, covered with a green epidermis, which is bright green toward the margin. It is concentrically, densely and finely striated. The anterior end is slopingly angled, and the posterior end is nearly straight. The shell is slightly arched in the middle. The right valve has two teeth, and the left valve has only one. The interior of the shell is somewhat pearly.

Length, 50 to 100 millimeters; breadth, 23 to 34.

MODIOLUS PHILIPPINARUM Hanley. Plate 10, fig. 3; Plate 11, fig. 4.

The shell is oblong-trapeziform and swollen. The exterior is yellowish brown and rayed, though sometimes obscurely. The anterior end is more or less distinctly incurved, and the posterior end is more or less rounded. The shell is concentrically, finely and densely striated. The interior of the shell varies from whitish to deep violet.

Length, 55 millimeters; breadth, 34.

MODIOLUS METCALFEI Hanley. Plate 11, figs. 2 and 3.

The shell is triangularly oblong and swollen. The exterior is greenish to yellowish brown with a band radiately descending from the umbo. It is smooth or very finely striated, in some specimens half covered toward the margin with a hairy brown epidermis. The posterior end is produced into a compressed wing, more keeled than that of *M. philippinarum* Hanley.

Length, 46 millimeters; breadth, 23.

JACKKNIFE CLAMS

SOLENIDÆ

Other names.—Elongated sea clams, "razor" clams, "razor" shells.

Vernacular names.—Tikhan, tikan (Tag.); tikhan, bilaog (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The jackknife clams, incorrectly called "razor" clams, belong to a family of agile bivalves occurring in sheltered places where they live buried vertically and deeply in sand and mud. Being elongated and roughly cylindrical the clams are naturally adapted for burrowing, each digging a rather smooth-line permanent burrow, 15 to 40 centimeters deep, within which it can move readily up and down. These mollusks are highly sensitive to disturbance and the quickness with which they retreat to a level of safety in the burrow is quite remarkable. When the ground is jarred by footsteps or by some hard object striking the soil the neck is withdrawn, leaving a depression in the sand, which reveals the location of the clam, and invariably a jet of water spouts up as the siphons are retracted; simultaneously, the foot, like a thin knife blade, flies out and cuts through the sand in an oblique downward course; then as the foot contracts its tip dilates forming a bulb which anchors it while the contraction draws the shell downward. This mechanical action of thrust and pull is repeated until the clam reaches the bottom of the burrow or beyond it if possible and necessary. Naturally, if the clam is not dug out quickly it will descend to a place of safety beyond the reach of the digger.

Jackknife clams have eyes in the form of ocelli or pigment spots, bordering the mantle margin around the siphons, and it is claimed that by means of these spots they can distinguish light from darkness to a remarkable degree, so much so that

a shadow cast over them will cause the sudden withdrawal of the protruding siphons.

In water, these cylindrical mollusks are proficient swimmers, darting here and there with remarkable celerity by snapping their two valves together. When a clam is captured it generally rehearses its burrowing propensity by rapidly extending and retracting its foot. When it is dropped on the sand it automatically works its way downward at the rate of several centimeters a minute.

METHOD OF COLLECTION

Because of their alertness and quickness to retreat rapidly upon being disturbed or alarmed, jackknife clams are not easy to gather and methods employed in taking other clams in which the ground is systematically dug over would be impracticable. Collectors working on the edge of the surf or on the exposed area on the shore watch for the holes to appear in the sand and dig the clams, one at a time, with the fingers or with an old bolo. In grounds where the clams are known to live but show no outside evidence of their presence, the diggers usually tap the ground with their feet or with some hard implement in order to force the creatures to move downward, thus betraying their location by a slight depression over each withdrawing individual. In water about waist deep the diggers explore the sandy bottom with the foot for razor clams. These are seized between the first and second toes, or are dived for and picked up with the hands.

UTILIZATION

Jackknife clams are extensively used as food. They are generally steamed or parboiled in the shell; the meats are tender and of a delicate flavor and make excellent soup or broth. The fresh clams are also shucked and the raw meats minced and prepared in various simple native ways. In the fish shops in Manila the clams are sold in the shell for about 10 centavos a kilogram.

DESCRIPTION OF THE SPECIES

The lone representative of jackknife clams in the Manila markets is *Pharella acutidens* Broderip and Sowerby.

PHARELLA ACUTIDENS Broderip and Sowerby. Plate 11, fig. 5; Plate 12, fig. 1.

The shell is elongated, narrow, and thin. The hinge line is nearly central with the anterior side shorter. The ventral mar-

gin is a little contracted. The exterior is covered with a thin dark brown or yellowish brown epidermis, which does not come off easily. It has fine concentric striations. The interior of the shell is yellow, turning to bluish white upon exposure.

Length, 70 to 74 millimeters; height, 15 to 16; breadth, 9 to 10.

DUCK-BILL CLAMS

ANATINIDÆ

Other names.—Truncated duck-bill shells, anatinas.

Vernacular name.—Lutos (Tag.).

OCCURRENCE, HABITAT, AND HABITS

The Anatinidæ are represented in the Philippines by about ten distinct forms of duck-bill clams, where they occur in muddy bottoms in the shallows along the coasts and in sheltered bays. In Manila Bay one species occurs quite abundantly at Navotas, Malabon, and Parañaque. This clam makes a deep vertical burrow which its shell fits snugly and within which it moves readily up and down. The burrow extends perpendicularly some 30 centimeters or more. Normally, the clam stays below the surface at a distance almost equal to its own length, from which level it extends its long neck upward; this beaklike extension gapes to allow the united and sheathed siphon tube to protrude. The animal is very sensitive to disturbance and withdraws itself suddenly whenever threatened.

UTILIZATION

The lutos is extensively utilized as food by the inhabitants living within reach of the beds, from which it is gathered alive by simply digging it out. The fresh clam is steamed or parboiled; and the meat, which is large and delicious, is eaten plain or with some sauce. In the markets live lutos are sold for 25 to 30 centavos a hundred.

DESCRIPTION OF THE SPECIES

The only species that is sometimes encountered in the Manila markets is *Anatina truncata* Lamarck.

ANATINA TRUNCATA Lamarck. Plate 12, figs. 2 and 3.

The shell is elongately oblong, thin, and translucent. The anterior end is squarely truncated, largely gaping, while the posterior end is compressedly rounded and but moderately gaping. The umboes are more or less fissured and are directed

backwards. The shell is concentrically wrinkled and granulated; the granules, however, are abruptly absent on the anterior area.

Length, 48 millimeters; height, 22; breadth, 16.

WEDGE SHELLS

DONACIDÆ

Other names.—Mural, bean clams, minute sand clams, "pompano" shells.

Vernacular names.—Alamis (Tag.); polopatanî (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The wedge shells are small mollusks found on sandy beaches or behind sand bars. In their natural habitat the wedge shells are usually encountered at the surface or slightly buried with the broadside towards the sea. Because of the comparatively heavy weight of their shells they are not easily carried back and forth by the waves; they can maintain their position on the sand by the aid of their foot which is quite large, elastic, and pointed; this is thrust obliquely outward and downward and dug into the wet sand, lifting the shell and drawing it under cover. Thus, in a way, the wedge shells are more or less active surface burrowers and as such can be easily collected by sifting the sand with the fingers or with a dredge-sieve made of bamboo splints.

UTILIZATION

The bean clams are among the best flavored of the small sand bivalves marketed. They are simply steamed or parboiled in their shells and make an excellent basis of a delicious soup. In the public markets fresh bean clams are sold for about 5 centavos a kilogram. The empty shells are used in lime making.

DESCRIPTION OF THE SPECIES

While there are several species of *Donax* reported from Manila Bay only one is sold in any quantity in the Manila markets. The lone species is *Donax radians* Lamarck.

DONAX RADIANS Lamarck. Plate 12, figs. 4 and 5.

The shell is triangularly egg-shaped and compressed. It is rather thick and inequilateral. The coloring is variable; grayish, whitish pink, sometimes rayed. The shell is concentrically striated. The posterior end is short, and the anterior end is longer and rounded. The interior of the shell is white, yellow, or deep violet.

Length, 16 millimeters; height, 18; breadth, 18.

HEART SHELLS

CARDIIDÆ

Other names.—Edible cockles, sand cockles.
Vernacular names.—Kanturî, butíl (Tag.); kayok (Vis.).

OCCURRENCE, HABITAT, AND HABITS

Members of this family are either marine or brackish-water forms occurring at intertidal zones, in sand or mud, and usually forming extensive beds in quiet bays and estuaries. They are more or less abundant near low water at Parañaque and Cavite.

The heart shells have siphons which are short and fringed at the tip, two gills on each side, and a large, sickle-shaped foot. Naturally, these clams are shallow active burrowers, moving about freely in a jerky and awkward manner. They can thrust the foot to its full extent and with it lift themselves with a twisting motion and come down a distance of a few centimeters. The foot expands at the tip so as to form a fulcrum on which the locomotory muscles act.

UTILIZATION

Undoubtedly several species of heart shells are collected and sold in the market with other clams. The kind known as kanturi appears to be the commonest marketed and is often mistaken for the butil (*Venus squamosa* Linnæus) which it closely resembles in external features and with which it is always associated in the natural habitat. The sand cockles are steamed or boiled in the shell, and the meat, which has a tasty flavor, makes an excellent soup or chowder. They are sold alive at from 3 to 5 centavos a hundred. The empty shells are used in lime making.

DESCRIPTION OF THE SPECIES

The only species encountered in the Manila markets is *Hemidonax donaciforme* Schroeter.

HEMIDONAX DONACIFORME Schroeter. Plate 12, figs. 6 to 8.

The shell is heart-shaped and rather solid. The posterior end is angulated. The exterior is whitish or orange yellow and is blotched on the posterior area. It is radiately grooved; the grooves on the anterior end are less distinct than those on the posterior end.

Length, 32 millimeters; height, 24; breadth, 20.

CYRENAS

CYRENIDÆ

Other names.—Little-neck clams, green clams.

Vernacular names.—For the large clams, lukan, tapalang, kabebe, bebe (Tag.); bebe, tuay, kayug (Vis.); for the small clams, tulya (Tag.); kagaykay (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The Cyrenidæ inhabit the sand or mud bottoms in fresh, salt, and brackish waters. Several forms occur on the tidelands of Manila Bay, in neighboring creeks and rivers, and in Laguna de Bay. These clams are active burrowers; the larger kinds are generally found buried to a depth of about 5 centimeters; the smaller ones are usually met with on or near the surface. They all have a large foot and short siphons but lack that tool for attachment, the byssus. They are bisexual; that is, the organs of both sexes are present in each individual. The young develop internally and are born possessing the external characters of the adult.

The species of *Corbicula,* locally known as tulya, apparently begins to spawn at a small size. Specimens 10 millimeters in length have been found sexually ripe. It is probable that under favorable conditions this species may become sexually mature at even smaller size. The frequency at which the tulya spawns within the twelve months at any given locality is not definitely determined. In all probability it spawns continuously during the year. A fair quantity of tulya of different sizes appears in the Manila markets practically every month of the year. However, during July, August, September, and October the amount marketed is greatest, thus indicating that spawning reaches its maximum during the previous months. The rate of growth of young tulya is comparatively rapid. In Laguna de Bay, it has been observed to increase at an average group rate of 0.18 centimeter in seven months.[8] At present nothing very definite is known about the biology of the larger as well as most of the smaller members of this group.

METHOD OF COLLECTION

The larger forms, coming under the popular name of lukan or tapalang, are collected in water 1 to 3 meters deep by feeling

[8] Villadolid, D. V., and F. G. Rosario, Philip. Agriculturist **19** (1930) 355–382.

them with the toes or fingers, and on the tide flats by scratching the ground with a tool like an old bolo or a flat piece of iron; the smaller clams, the tulla or tulya, found in creeks, rivers, and lakes are generally gathered by dredging them with especially designed dredge nets or dredge sieves of bamboo splints; and those found in very shallow water or in exposed areas during ebb tide are obtained by sifting the ground with the fingers.

UTILIZATION

The lukan and tulya are of considerable economic importance, being used extensively and in large quantities as food for ducks and for man. The clams are simply boiled or steamed, often with slices of ginger root to flavor the resulting broth, and the meats are eaten plain or with vinegar sauce. The shellfish may be shucked and the raw meats prepared with pork, beef, shrimps, and vegetable.

DESCRIPTION OF THE SPECIES

The commonest species sold in the markets are *Cyrena ventricosa* Deshayes and *Corbicula fluminea* Muller. We would have preferred to retain the name of *Corbicula manilensis* Philippi, for the Philippine species of *Corbicula fluminea* Muller as suggested by Prashad of the Indian Museum, but with the very great number of specimens collected we could not justify the retention of the name for geographical reasons alone.

CYRENA VENTRICOSA Deshayes. Plate 14, figs. 1 and 2.

The shell is large and thick. The exterior is pale yellow and is concentrically fringe-striated. The anterior end is short and rounded, and the posterior end is produced and somewhat obtusely angled. The interior of the shell is white.

Length, 64 millimeters; height, 60; breadth, 30.

CORBICULA FLUMINEA Muller. Plate 14, figs. 3 to 8.

The shell is more or less triangular in shape and gibbous. It is high and nearly equilateral. The exterior is covered with a smooth, shining, yellowish brown epidermis. The concentric ridges are strong and far apart. The umboes are raised. The dorsal margin is sloped on each side. The posterior end forms an obscure angle and its epidermis is dull and fringed. The interior of the shell is whitish to bluish white.

Length, 28 millimeters; height, 28; breadth, 18.

FRESH-WATER MUSSELS

UNIONIDÆ

Other names.—Fresh-water clams, river clams, unios.

Vernacular names.—Sulib, paros (Tag.); balisalá, balinday (Vis.); balihará (Zam.).

OCCURRENCE, HABITAT, AND HABITS

Fresh-water mussels are found inhabiting the sandy or muddy bottoms of creeks, rivers, and lakes. Laguna de Bay and Pasig River and other rivers near Manila yield a considerable quantity. The clams are usually encountered buried about five centimeters below the surface of the sand or mud, which indicates that the mollusks are shallow burrowers; in fact, they are more or less migratory in habit, moving about freely on the bottom by means of the large foot. Like most bottom dwellers, these clams subsist mainly upon dissolved organic matter and microscopic organisms in their environment. The young hatch from the eggs already provided with shells.

UTILIZATION

Considerable numbers of these river clams, which are collected from Laguna de Bay and Pasig River by simply sifting the sand with the fingers or dredging with some sort of dredge sieve made of bamboo splints, are brought to the public markets in Manila where they are known as paros or sulib and sold for from 15 to 40 centavos a hundred. The mussels are steamed or boiled in the shell, and the cooked meat, which is large and tender, is eaten plain or mixed with vegetables. The empty shells are used in the making of lime.

DESCRIPTION OF THE SPECIES

The commonest unio sold in the markets is *Dalliella subcrassa* Lea.

DALLIELLA SUBCRASSA Lea. Plate 10, figs. 1 and 2.

The shell is subrhomboidal to oblong and is fairly thick. The exterior is dull brown with a greenish or yellowish tint and is smooth. It is concentrically striated. The anterior end is short and rounded; the posterior end is obtusely produced and roundly angular. The dorsal margin is straight, and the ventral margin is slightly contracted at the middle. The umboes are smooth, prominent, and purplish. The interior of the shell is purplish.

Length, 60 millimeters; height, 35; breadth, 21.

STROMBUS SHELLS

STROMBIDÆ

Other names.—Strombs, wing shells, conch shells, "fountain shells," "buzzard mollusks."

Vernacular names.—Balákwit, buláksik, palagsí (Tag.); liswí, sikád (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The Strombidæ found along the shores of Manila Bay are mainly littoral in occurrence. They are active, moving about freely in a peculiar gait by means of the foot, which is narrow in front and arched and broad behind; they are instinctively alert and show power of discrimination which almost approaches intelligence. It has been observed that these conch shells are rather impulsive in temperament and do not glide as most bivalves do but jump along, driving the sharp point of the claw or operculum (that horny plate of cuticle on the hind portion of the foot) into the ground, and flopping the shell from side to side as they progress. When frightened they try to get away by leaps and bounds, making turns to escape capture. If placed on their back they can right themselves by a somersault. Those crawling on rocks are usually noticed moving in a sort of unstable equilibrium, which is due to the fact that the shell is quite heavy for the foot to lift; and at a slight push of the operculum the strombs roll down. In this way they generally get back to the water after being left exposed on the rocks or sloping sand beach by the tide.

These mollusks are believed to feed mainly on flesh, which they tear by means of the well-developed radula, or rasping tongue. Their sense of smell is as keen as their eyesight. On account of their liking for flesh those living among coral rocks may be captured with a bait of meat; but those on the sandy beaches can, of course, be easily gathered by simply picking them up.

UTILIZATION

A fair number of strombus shells appears in the public markets where they are sold fresh in the shell for from 5 to 8 centavos a dozen. They are steamed or boiled in the shell or simply baked over a fire, and the meat is generally removed by pulling it out by the hard cuticle or prying it out with a sharp tool. The flesh has a characteristic taste and when eaten plain gives an after-effect that increases one's craving for drinking water.

The empty shells are utilized in lime making and also as sinkers of fishing nets. To fit them for the last-named purpose, the apex of each shell is broken off, and then the shells are strung at intervals along the ground rope of nets.

DESCRIPTION OF THE SPECIES

The strombs are only occasionally met with in the Manila markets, and the species generally present is *Strombus canarium* Linnæus.

STROMBUS CANARIUM Linnæus. Plate 15, fig. 5.

The shell is shortly egg-shaped, somewhat heart-shaped. It is thick, heavy, and solid. The color is pale brownish or yellowish white, densely, longitudinally marked with alternating brown and white lines. The spire is rather sharp; the whorls are smooth and gibbous and linearly grooved towards the apex. The columella is very callous. The lip is winged and thickened. The aperture is white.

Length, 56 millimeters.

MELONGENAS

BUCCINIDÆ

Other names.—Whelk, conch.

Vernacular names.—Kalaunghuga (Tag.); kahángkaháng, alánalán (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The melongenas, which belong to a large and aggressive family of carnivorous mollusks, have been found on the shores of Manila Bay, particularly at Malabon, Navotas, Parañaque, Binakayan, and Kawit. They occur singly and prefer to live in brackish water and among clams and the nonresistant oysters. It is not uncommon to observe a number of melongenas surrounding some oysters, watching until the latter let their shells gape when the gastropods all thrust in their long and tough snouts; when the muscle of the oyster is reached the radula or rasping tongues of the aggressors soon overpower the prey.

UTILIZATION

The melongenas are used for food and marketed in the shell in the local markets where they bring from 5 to 10 centavos a dozen. The gastropods are steamed or boiled or simply placed over a fire until the animal is cooked when it is extracted by prying it out or breaking the shell. The boiled or steamed

meat is eaten plain or with some sauce or cooked with a vegetable. The empty shells are utilized in lime making.

DESCRIPTION OF THE SPECIES

Melongena pugilina Born and *Melongena galeodes* Lamarck are the two common species encountered. The first is very popular and eagerly sought, while the second does not have much demand.

MELONGENA PUGILINA Born. Plate 16, figs. 1 and 2.

The shell is somewhat mango-shaped, inflated, and thick. It is yellowish brown or dark brown, and is covered with hairy somewhat velvety epidermis. The whorls are spirally ridged towards the apex and are tubercled. The aperture is orange yellow.

Length, 88 millimeters.

MELONGENA GALEODES Lamarck. Plate 16, figs. 3 and 4.

The shell is smaller than that of *M. pugilina* Born. It is pale brown, whitish, or cream color. The spines are rather sharp, and the whorls are generally frilled or scaly and full of spines at the sutural line. The shoulder is provided with spines or nodules and below it is another row of spines. The aperture is white.

Length, 50 to 55 millimeters.

HORN SHELLS

CERITHIIDÆ

Vernacular names.—Susô, susóng dagat, susóng putî, bayoñgon, bañgoñgon (Tag.); susô, awis, bagoñgon (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The horn shells live in brackish and fresh water on rocks or among marine vegetation. There are some which are able to live for long periods out of water, attaching themselves to trunks and stems of marsh plants by means of mucus that affixes the lip to the objects in their habitat. They are primarily littoral in distribution, inhabiting the muddy ground of swamps, estuaries, and fishponds. Around Manila Bay incredible numbers of the smaller kinds are found on the tide flats, buried, exposed, or entangled among algæ and other water plants. A considerable quantity of the larger forms can also be found in similar surroundings; these, however, occur singly and are

more or less active, crawling on the ground by means of the large foot.

These mollusks subsist mainly upon algæ and diatoms, which are abundant in their natural habitat. They are apparently very prolific. Facts about their spawning season and the frequency at which they reproduce at a given locality within a given time and their rate of growth are not definitely known.

UTILIZATION

The horn shells are all edible and are extensively used as food in the Philippines. The smaller kinds, which are collected in quantity by simply raking them in, are utilized more for lime making, while the larger species are gathered primarily for human consumption. Both kinds when consumed for food are steamed or boiled; the apex of each shell is broken off and then the flesh is sucked out through the large opening. The meat has a piquant taste which increases the desire for frequent drinking of water. In the public markets the smaller shells, known as susô, sell at 5 centavos per kilogram; the larger kinds, or bañgoñgon, at about 10 centavos per kilogram.

DESCRIPTION OF THE SPECIES

The three species that have been identified in the lot of specimens generally offered for sale in the markets are *Potamides (Telescopium) telescopium* Linnæus, *Potamides (Cerithidea) rhizoporarum* A. Adams, and *Potamides (Terebralia) sulcatus* Born. The most important species, however, is *Potamides (Telescopium) telescopium* Linnæus.

POTAMIDES (TELESCOPIUM) TELESCOPIUM Linnæus. Plate 15, fig. 1.

The shell is cone-shaped and dark brown. The whorls are numerous and on them are winding narrow channels which divide broader, flat-topped ridges. The base is strongly ridged, and the columella is spirally twisted. The outer lip is expanded and is produced beneath.

Length, 90 millimeters.

POTAMIDES (CERITHIDEA) RHIZOPORARUM A. Adams. Plate 15, fig. 4.

The shell is cylindrical, rather solid, and brown. The whorls are provided with numerous rounded ribs cut into nodules by spiral ridges. The aperture is rounded and notched at the base of the columella. The outer lip is expanded, and the apex is sometimes worn away.

Length, 30 millimeters.

POTAMIDES (TEREBRALIA) SULCATUS Born. Plate 15, figs. 2 and 3.

The shell is subpyramidal, somewhat swollen, and brown. The whorls are longitudinally and strongly ribbed and are tuberculated by the crossing of incised spiral grooves. The aperture is mango-shaped. The outer lip is expanded, bent around, and joined with the inner lip, crossing and partially closing the anterior canal.

Length, 50 millimeters.

WHEEL SHELLS

UMBONIDÆ

Vernacular names.—Kaligay (Tag.); batad (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The members of this family are small mollusks inhabiting sandy shores of bays and open seacoasts. A few forms have been encountered in Manila Bay. Apparently the sandy beaches of Pasay and Parañaque are the most favorable grounds for kaligay, as practically all that enter the public markets come from these localities where they occur in beds or scattered groups.

Where the sand is covered with a few centimeters of water the kaligay may be seen gliding along on the bottom; on the moist exposed sandy beaches they may also be noticed moving slightly under the surface; it is not uncommon to find them completely covered; but generally they leave characteristic tracks, which when traced betray their location. Being small the wheel shells are at the mercy of the elements; and but for the flatness of their shell and their ability to right themselves, they would not survive in such an unstable surrounding, which is always being shifted by the waves and currents. It is interesting to note that the kaligay are rarely seen upturned unless dead. The foot is apparently a very effective organ not only for locomotion but for anchorage as well.

UTILIZATION

The kaligay, although small, are nevertheless of some economic importance due to their abundance and the facility with which they are gathered in quantities, and to the characteristic flavor of the meat which is relished by Filipinos. In Pasay and Parañaque great numbers are collected by simply sifting the sand with the fingers. Sackfuls are brought to the local markets, where they are sold for 5 centavos a kilogram. The kaligay

are marketed cooked; they are steamed or boiled much as clams are steamed in the shell. Since the flesh is small and quite difficult to extract, the vendor gives the buyers thorns of aroma, *Acacia pennata* (Linn.) Willd., with which to pry the meat out. However, a pin is just as effective a tool to remove the snail. Kaligay eating is indulged in as an after-meal pastime.

DESCRIPTION OF THE SPECIES

The only species encountered in the markets and among the street vendors is *Umbonium vestiarium* Linnæus.

UMBONIUM VESTIARIUM Linnæus. Plate 11, figs. 6 to 10.

The shell is small and depressed, thin but strong. It is shining, polished, and smooth. The colors are variable, and the combinations present striking patterns. The whorls, numbering about six, are rounded at the periphery. The callus pad is large, polished, and convex. The aperture is somewhat heart-shaped and is iridescent within.

Altitude, 10 millimeters; diameter, 15.

All the more usual color patterns known have been encountered, but the more numerous are those finely mottled above, the base white or plain colored, the peripheral zone the same as the general pattern, or with large radiating spots, or a white-edged girdle of red.

FRESH-WATER SNAILS

PILIDÆ, OR AMPULLARIIDÆ

Other names.—River snails, pond snails, marsh snails, apple snails, flask snails, ampullarias.

Vernacular names.—Kohol, egue, susóng bilog, susóng pang-pang, susóng tabang (Tag.); kool, ege, agos-os (Vis.); betocol (Zam.); bisocol (Il.).

OCCURRENCE, HABITAT, AND HABITS

The Pilidæ, or Ampullariidæ, are an amphibious family of mollusks which are represented by a number of species occurring abundantly in fresh-water ponds and marshes, creeks, and paddy fields. In Laguna de Bay and Pasig River and near-by streams at least three species are found in large quantities, living on sandy bottoms in shallow water and among water plants and submerged objects upon which they crawl about in a gliding movement by means of the broad flat foot.

The snails are at home in and out of the water by virtue of the peculiar character of the gills, which lie in a large, partially closed, breathing chamber. In time of drought they retreat under the mud and live there for months in a state of suspended animation (æstivation). Indeed, these pond snails survive removal from the water for remarkably long periods, breathing air but all the while keeping the breathing cavity moist. In habit they are gregarious and strictly vegetarian, subsisting upon the roots, leaves, and stems of aquatic plants.

In Pilidæ, or Ampullariidæ, the sexes are separate; that is, the individual is either male or female. According to a recent investigation [9] one species, *Pila luzonica* Reeve, found in Laguna de Bay, has been observed to attain sexual maturity at the age of about 6 months when the male has an average length of 27.61 millimeters and the female 29.12 millimeters. In places where there is always water this species has been found to spawn continuously throughout the year; it deposits its eggs on roots, stems, and leaves of aquatic plants and on the sides of dikes of rice fields and irrigation ditches; the eggs are nearly always laid on objects at water level since when submerged in water they do not hatch.

METHOD OF COLLECTION

The snails living in groups on the sandy bottom are readily collected by a sort of long-handled scraper, the pañgahig (fig. 6), or dredge net, operated from a banca. The snails clinging to water plants and dikes are simply gathered by hand.

UTILIZATION

Although more commonly regarded as poultry feed than as food for man, kohol are also eaten extensively by poor people. It has been estimated that no less than 15,000 liters of kohol are used daily in the poultry industry at the southwestern shores of Laguna de Bay, and a considerable quantity is utilized as food by the inhabitants of Laguna Province, besides the fairly large amounts brought to the public markets in Manila where they are sold as human food for from 4 to 10 centavos a hundred. The snails are cooked in the shell in combination with a species of edible fern, pakó, *Athyrium esculentum* Copeland, or with gábi, *Colocasia esculentum* (Linnæus) Schott, and coconut milk. The flesh is sucked out through the opening after the peak or

[9] Nono, A. M., and A. M. Mane, Philip. Agriculturist 19 (1931) 675–695.

tip of each shell has been broken off to facilitate sucking. The raw meat is also utilized to some extent as bait for line fishing.

DESCRIPTION OF THE SPECIES

The commonest and most important of these snails is *Pila luzonica* Reeve.

PILA LUZONICA Reeve. Plate 17, figs. 4 to 6.

Ampullaria luzonica REEVE.

The shell is shaped somewhat like a swollen globe. It is reddish yellow or reddish brown, thin, smooth, and at times shining. The whorls are flatly impressed around the upper part, then rounded. They are densely, finely, and longitudinally striated, also obscurely banded. The aperture is egg-shaped and rather large.

Altitude, 40 millimeters; diameter, 36.

FRESH-WATER SNAILS

VIVIPARIDÆ

Other names.—Pond snails, river snails, viviparas.

Vernacular names.—Kohol, egue, susô, susóng pangpang (Tag.); ege (Vis.); bisocol (Il.); betocol (Zam.).

OCCURRENCE, HABITAT, AND HABITS

The Viviparidæ are found in fresh and brackish water. In Laguna de Bay and its tributaries several species of viviparas have been found to occur more or less abundantly on sandy or muddy bottoms in shallow water and among water plants and submerged objects. Like the ampullarias, they are active and gregarious; they crawl about by means of the broad flat foot and feed on growing and decaying algæ and other decaying vegetable matter, and dissolved organic material or detritus formed on the surface of the muddy bottom.

The viviparas are self fertilizing live-bearing mollusks; they are hermaphroditic; that is, both reproductive organs are present in each individual, and they produce eggs that are incubated and hatched within the parent's body. The young are born already possessing all the external characters of the adult.

In a recent study on the biology of *Vivipara angularis* Muller [10] (*Vivipara burroughiana* Lea) it has been observed that this species becomes sexually mature at the age of about 2 months

[10] Alonte, F. H., Philip. Agriculturist **19** (1930) 307–325.

when it attains an average length of 19.09 millimeters and an average width of 15.4 millimeters.

Generally the viviparas are most abundant in Pasig River and Laguna de Bay from January to April, which indicates that the height of the spawning season in the region is during the previous months.

METHOD OF COLLECTION

The viviparas are collected in quantity in the same manner as the ampullarias. Those on the beds of lakes, rivers, and creeks are dredged by various sorts of dredge nets operated from bancas; those clinging to aquatic plants and submerged objects like the *bonbon*, which consists of bundles of switches placed in the water for catching shrimps, are picked by hand.

UTILIZATION

These snails are the most valued for duck feed; they are to some extent used as food by the inhabitants around Laguna de Bay and in Manila and vicinity. The snails are prepared for the table in the same manner as the ampullarias. In the public markets in Manila they sell for about 6 centavos a hundred.

DESCRIPTION OF THE SPECIES

Apparently the only species gathered and sold for food is *Vivipara burroughiana* Lea.

VIVIPARA BURROUGHIANA Lea. Plate 17, figs. 7 and 8.

The shell is elevately conical and green to greenish brown. It is delicately formed and rather thin. The whorls are more or less sharply angled at the upper part and spirally corded with fine ribs. The ribs are generally three, sometimes more, and there are other finer ridges between them. Both ribs and ridges are crossed by strong striations.

Altitude, 33 millimeters; diameter, 23.

FRESH-WATER HORN SHELLS

THIARIIDÆ, OR MELANIIDÆ

Other names.—Melanias, black snails, marsh snails.

Vernacular names.—Susô, susóng buele, sambuele, susóng tabang, susóng pilipit, bilibid (Tag.); banág, susô, awis (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The Melaniidæ, represented by numerous species, inhabit shallow creeks and ponds, swift streams and rapids. In Pasig River

and Laguna de Bay at least four species are known to occur very abundantly.

The melanias are active and strong, carrying around their turreted shells with remarkable ease; they are not strictly gregarious so that in their natural habitat they are met with either singly or in scattered groups of a few individuals. They feed on algæ and other aquatic plants. The melanias are very prolific and generally bring forth the young already possessing all the external characters of the adult.

UTILIZATION

Like the ampullarias and viviparas, these fresh-water black horn shells, gathered from Laguna de Bay and the streams around it, are extensively used as poultry feed, particularly by duck raisers; they are also utilized as food for man. In the public markets in Manila they sell at from 10 to 20 centavos a hundred.

DESCRIPTION OF THE SPECIES

The largest of the species and the one sold in the markets for human consumption is *Thiara asperata* Lamarck.

THIARA ASPERATA Lamarck. Plate 17, figs. 1 to 3.

Melania asperata LAMARCK.

The shell is generally eroded towards the apex. It is reddish brown to dark brown and more or less solid. The whorls, numbering twelve or more, are longitudinally and plicately ribbed. They are also transversely and spirally ridged. The aperture is subcircular, and the inner lip is somewhat callous.

Altitude, 60 millimeters; diameter, 18.

TONGUE CLAMS

LINGULIDÆ

Other names.—Lamp shells, lingulas, brachiopods.

Vernacular names.—Bálay (Tag.); úgpan (Vis.).

OCCURRENCE, HABITAT, AND HABITS

The Lingulidæ are well represented in the Philippines by *Lingula unguis* Linnæus. In Manila Bay this species, locally known as bálay, occurs in large numbers, living in vertical burrows in shallow water along the shores of Pasay, Malabon, Puerto Rivas, and Balanga.

In the natural habitat the bálay is generally found with the stalk buried and the shell partly exposed above the surface. On

grounds with clear shallow water and in pools left by the receding tide, it is usually seen partly out of its burrow, with the valves gaping and the setæ vibrating in unison, thus producing a sort of channel as the water flows in and out in definite currents. The animal is breathing and feeding simultaneously in this manner.

The bálay is sensitive to disturbance; its peduncle or stalk is capable of withdrawing the shell suddenly whenever alarmed, leaving a slitlike hole in the ground; this aperture betrays the presence of the animal and experienced diggers can detect it from a fair distance and take advantage of this fact when collecting the shellfish.

The bálay is an active digger and its burrowing methods are interesting. It may dig on its side using the stiff hairs to plow into the sand while forcing the body forward; it may penetrate the ground by means of the peduncle, in the manner of a worm, dragging the body down as it cleaves the sand; or, it may bury itself head first, a method usually exhibited by an individual with the peduncle broken close to the body.

In all probability the bálay spawns throughout the year in Manila Bay. During June and July particularly great quantities appear in the public markets in Manila, which indicates that possibly the height of the spawning period is during the previous months.

UTILIZATION

The bálay is extensively used as food, especially by the people living near the grounds. Considerable quantities are brought into the public markets where they sell for about 15 centavos a hundred. The stalk is generally eaten fresh or pickled in vinegar.

DESCRIPTION OF THE SPECIES

The specific name *anatina* has long been in use for this species, but we agree with Dall [11] that *unguis* has priority and therefore use it here.

LINGULA UNGUIS Linnæus. Plate 17, figs. 9 and 10.

The shell is thin and horny. It is oblong-shaped with the sides nearly straight and subparallel, contracting about the edges in drying. The anterior end is rounded, the posterior is attenuated, and the beak is sharply acuminated. The valves are slightly convex, most convex at the middle, but somewhat flat-

[11] Proc. U. S. Nat. Mus. 57 (1920) 262.

tened laterally. They are closed on each side but slightly gaping at the beak. The surface is smooth with fine concentric lines and radial striæ. There are obscure carinæ, particularly at the median line, extending from the beak to the anterior end. The color is various shades of green, somewhat brownish near the beak.

The interior is sometimes whitish. The ventral valve is somewhat larger. Its beak tapers acutely to a point and has a channel in the middle to which the peduncle is attached. The dorsal valve is somewhat shorter. Its beak is obtusely rounded with a thickened hinge margin. At the center is a raised elongated ridge.

Length of shell, 45 millimeters; greatest diameter, 20; length of peduncle, 80.

ILLUSTRATIONS

PLATE 1

FIGS. 1 and 2. *Ostrea iredalei* Faustino, interior of lower or left valve.
3 and 4. *Ostrea malabonensis* Faustino, exterior of lower valve.
FIG. 5. *Ostrea malabonensis* Faustino, interior of upper valve.
6. *Ostrea malabonensis* Faustino, interior of lower valve.

PLATE 2

FIGS. 1 and 2. *Ostrea iredalei* Faustino, interior of upper valve.
FIG. 3. *Ostrea iredalei* Faustino, exterior of upper valve.

PLATE 3

FIG. 1. *Ostrea palmipes* Sowerby, interior of lower valve.
2. *Ostrea palmipes* Sowerby, interior of upper valve.
3. *Ostrea palmipes* Sowerby, exterior of lower valve.
4. *Ostrea malabonensis* Faustino, interior of upper valve.
5. *Paphia hiantina* Lamarck, exterior of right valve.
6. *Paphia hiantina* Lamarck, interior of left valve.

PLATE 4

FIG. 1. *Paphia hiantina* Lamarck, exterior of left valve.
2. *Paphia ferruginea* Reeve, exterior of left valve.
3. *Paphia ferruginea* Reeve, interior of left valve.
4. *Paphia hiantina* Lamarck, interior of right valve.
5. *Paphia hiantina* Lamarck, exterior of right valve.
6. *Paphia striata* Chemnitz, interior of right valve.
7. *Paphia striata* Chemnitz, exterior of left valve.
8. *Paphia turgida* Lamarck, interior of right valve.
9. *Paphia turgida* Lamarck, exterior of left valve.

PLATE 5

FIG. 1. *Circe gibba* Lamarck, exterior of left valve.
2. *Circe gibba* Lamarck, interior of left valve.
3. *Circe pectinata* Linnæus, exterior of left valve.
4. *Circe pectinata* Linnæus, interior of left valve.
5. *Circe divaricata* Chemnitz, exterior of right valve.
6. *Circe divaricata* Chemnitz, interior of left valve.
7. *Circe gibba* Lamarck, exterior of right valve.
8. *Circe pectinata* Linnæus, exterior of right valve.

PLATE 6

FIG. 1. *Circe scripta* Linnæus, exterior of right valve.
2. *Circe scripta* Linnæus, interior of left valve.
3. *Venus (Anaitis) alta* Sowerby, jr., interior of left valve.
4. *Venus (Anaitis) alta* Sowerby, jr., interior of left valve.
5. *Venus (Anomalocardia) squamosa* Linnæus, interior of left valve.
6. *Venus (Anomalocardia) squamosa* Linnæus, exterior of right valve.
7. *Mactra mera* Deshayes, interior of left valve.
8. *Mactra mera* Deshayes, exterior of right valve.

PLATE 7

FIG. 1. *Arca antiquata* Linnæus, interior of left valve.
2. *Arca antiquata* Linnæus, exterior of right valve.
3. *Arca binakayanensis* Faustino, interior of left valve.
4. *Arca binakayanensis* Faustino, exterior of right valve.
5. *Arca cepoides* Reeve, interior of left valve.
6. *Arca cepoides* Reeve, exterior of right valve.
7. *Arca antiquata* Linnæus, interior of right valve.

PLATE 8

FIG. 1. *Arca chalcanthum* Reeve, interior of left valve.
2. *Arca chalcanthum* Reeve, exterior of right valve.
3. *Arca cornea* Reeve, exterior of left valve.
4. *Arca cornea* Reeve, interior of right valve.
5. *Arca inæquivalvis* Bruguière, interior of left valve.
6. *Arca inæquivalvis* Bruguière, exterior of left valve.

PLATE 9

FIG. 1. *Macoma pellucida* Philippi, interior of left valve.
2. *Macoma pellucida* Philippi, exterior of right valve.
3. *Soletellina (Soletellina) cumingiana* Deshayes, interior of right valve.
4. *Soletellina (Soletellina) cumingiana* Deshayes, exterior of left valve.
5. *Soletellina (Soletellina) cumingiana* Deshayes, interior of left valve.
6. *Soletellina (Psammotæa) minor* Deshayes, interior of left valve.
7. *Soletellina (Psammotæa) minor* Deshayes, exterior of right valve.

PLATE 10

FIG. 1. *Dalliella subcrassa* Lea, interior of right valve.
2. *Dalliella subcrassa* Lea, exterior of left valve.
3. *Modiolus philippinarum* Hanley, interior of left valve.
4. *Soletellina (Psammotæa) elongata* Lamarck, interior of left valve.
5. *Soletellina (Psammotæa) elongata* Lamarck, exterior of right valve.

PLATE 11

FIG. 1. *Mytilus smaragdinus* Chemnitz, exterior of left valve.
2. *Modiolus metcalfei* Hanley, interior of left valve.
3. *Modiolus metcalfei* Hanley, exterior of right valve.
4. *Modiolus philippinarum* Hanley, exterior of left valve.
5. *Pharella acutidens* Broderip and Sowerby, exterior of left valve.
FIGS. 6 to 10. *Umbonium vestiarium* Linnæus.

PLATE 12

FIG. 1. *Pharella acutidens* Broderip and Sowerby, interior of left valve.
2. *Anatina truncata* Lamarck, interior of left valve.
3. *Anatina truncata* Lamarck, exterior of left valve.
4. *Donax radians* Lamarck, interior of left valve.
5. *Donax radians* Lamarck, exterior of right valve.
6. *Hemidonax donaciforme* Schroeter, interior of left valve.
7. *Hemidonax donaciforme* Schroeter, exterior of right valve.
8. *Hemidonax donaciforme* Schroeter, exterior of left valve.

PLATE 13

FIG. 1. *Mytilus smaragdinus* Chemnitz, interior of left valve.
FIGS. 2 and 3. *Mytilus smaragdinus* Chemnitz, interior of right valve.

PLATE 14

FIG. 1. *Cyrena ventricosa* Deshayes, interior of left valve.
2. *Cyrena ventricosa* Deshayes, exterior of right valve.
3. *Corbicula fluminea* Müller, interior of right valve.
4. *Corbicula fluminea* Müller, interior of left valve.
5. *Corbicula fluminea* Müller, exterior of right valve.
6. *Corbicula fluminea* Müller, exterior of right valve.
7. *Corbicula fluminea* Müller, interior of right valve.
8. *Corbicula fluminea* Müller, interior of left valve.

PLATE 15

FIG. 1. *Potamides (Telescopium) telescopium* Linnæus.
FIGS. 2 and 3. *Potamides (Terebralia) sulcatus* Born.
FIG. 4. *Potamides (Cerithidea) rhizoporarum* A. Adams.
5. *Strombus canarium* Linnæus.

PLATE 16

FIGS. 1 and 2. *Melongena pugilina* Born.
3 and 4. *Melongena galeodes* Lamarck.

PLATE 17

FIGS. 1 to 3. *Thiara asperata* Lamarck.
4 to 6. *Pila luzonica* Reeve.
7 and 8. *Vivipara burroughiana* Lea.
FIG. 9. *Lingula unguis* Linnæus, interior.
10. *Lingula unguis* Linnæus, exterior.
11. *Lingula unguis* Linnæus, with peduncle, or stalk.

PLATE 18

FIG. 1. Piles of oysters, Malabon, Rizal. The larger pile, in the background, consists of dead shells; the smaller pile, in the foreground, contains live oysters.

2. Scattering dead oyster shells to catch oyster spat, Malabon, Rizal.

TEXT FIGURES

FIG. 1. *Meretrix meretrix* Linnæus, left valve; *A*, anterior end; *P*, posterior end; *D*, dorsal margin; *V*, ventral margin; *AP*, length of shell; *VD*, height of shell; *h*, ligament, or hinge line; *u*, beak, or umbo; *c*, hinge, or cardinal, teeth; *l*, lateral tooth; *am*, anterior adductor muscle scar; *pm*, posterior adductor muscle scar; *pl*, pallial line; *ps*, pallial sinus.

2. *Meretrix meretrix* Linnæus, right valve; lettering the same as in fig. 1.

3. *Meretrix meretrix* Linnæus; *b*, breadth; *lu*, lunule; *u*, umbo; *l*, ligament area.

4. *Murex torrefactus* Sowerby, young; *a*, apex; *s*, spire; *m*, mouth, or aperture; *o*, outer lip; *ac*, anterior canal; *co*, columella; *va*, varix; *su*, suture; *b*, body whorl; *sb*, shoulder of whorl.

5. The kulakud.

6. The pañgahig; *h*, handle, *s*, iron nails; *w*, wire netting.

PLATE 1.

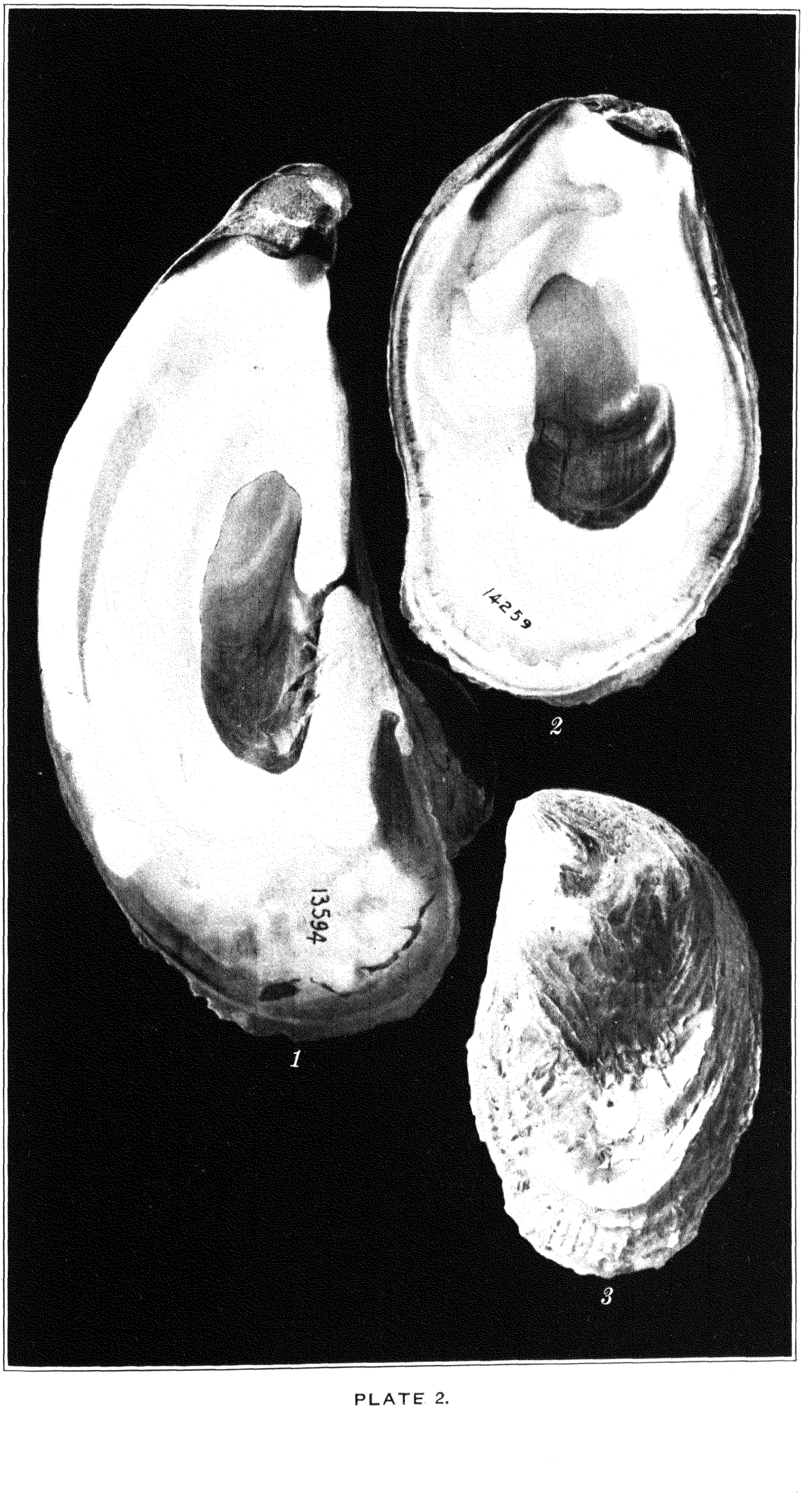
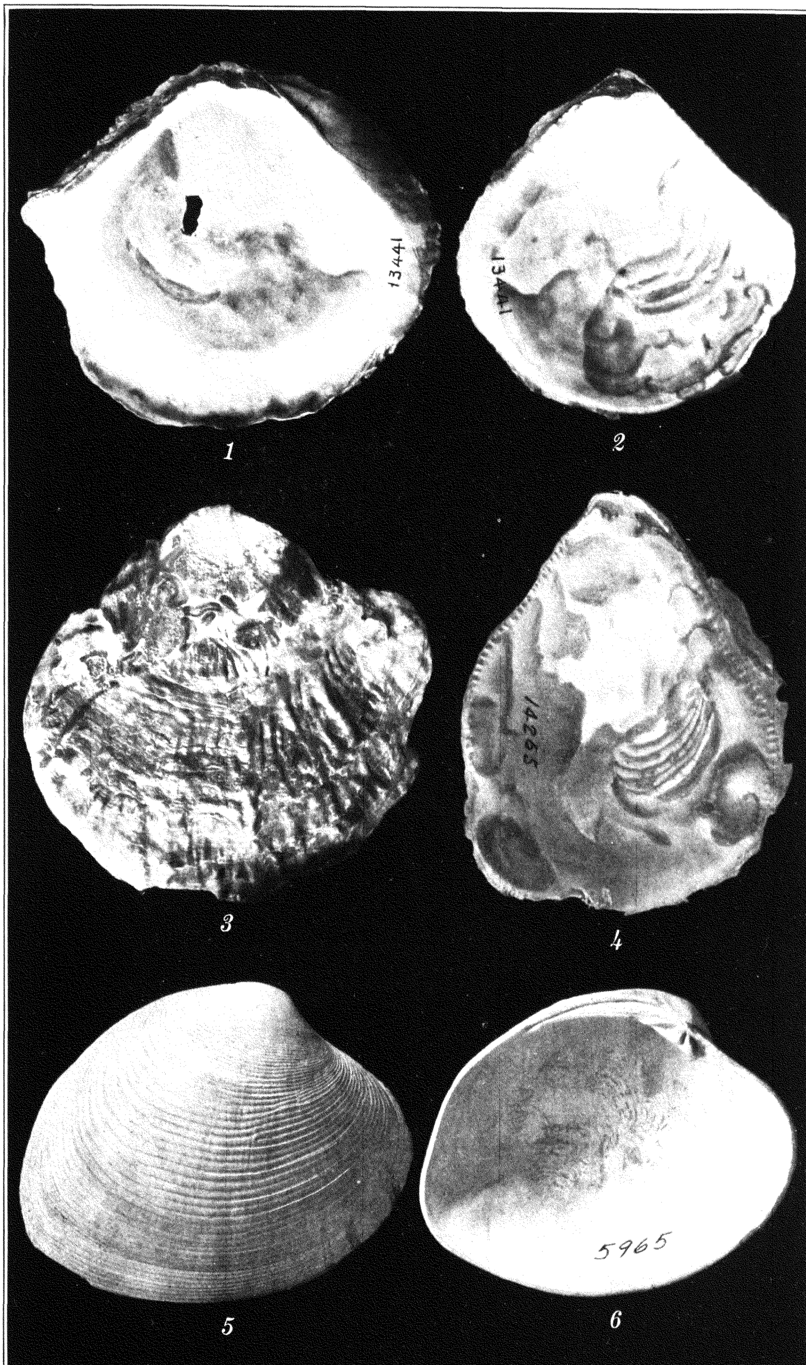


PLATE 2.



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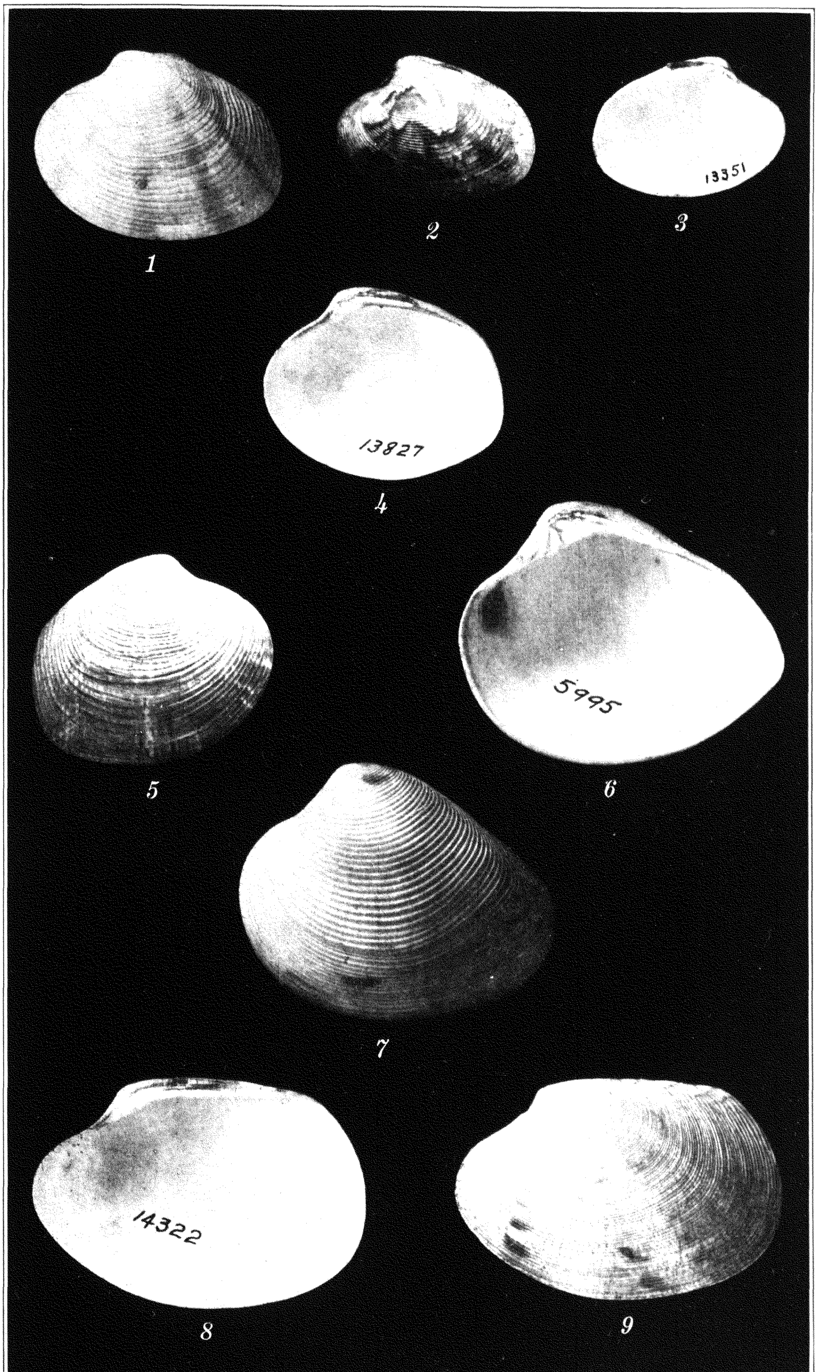

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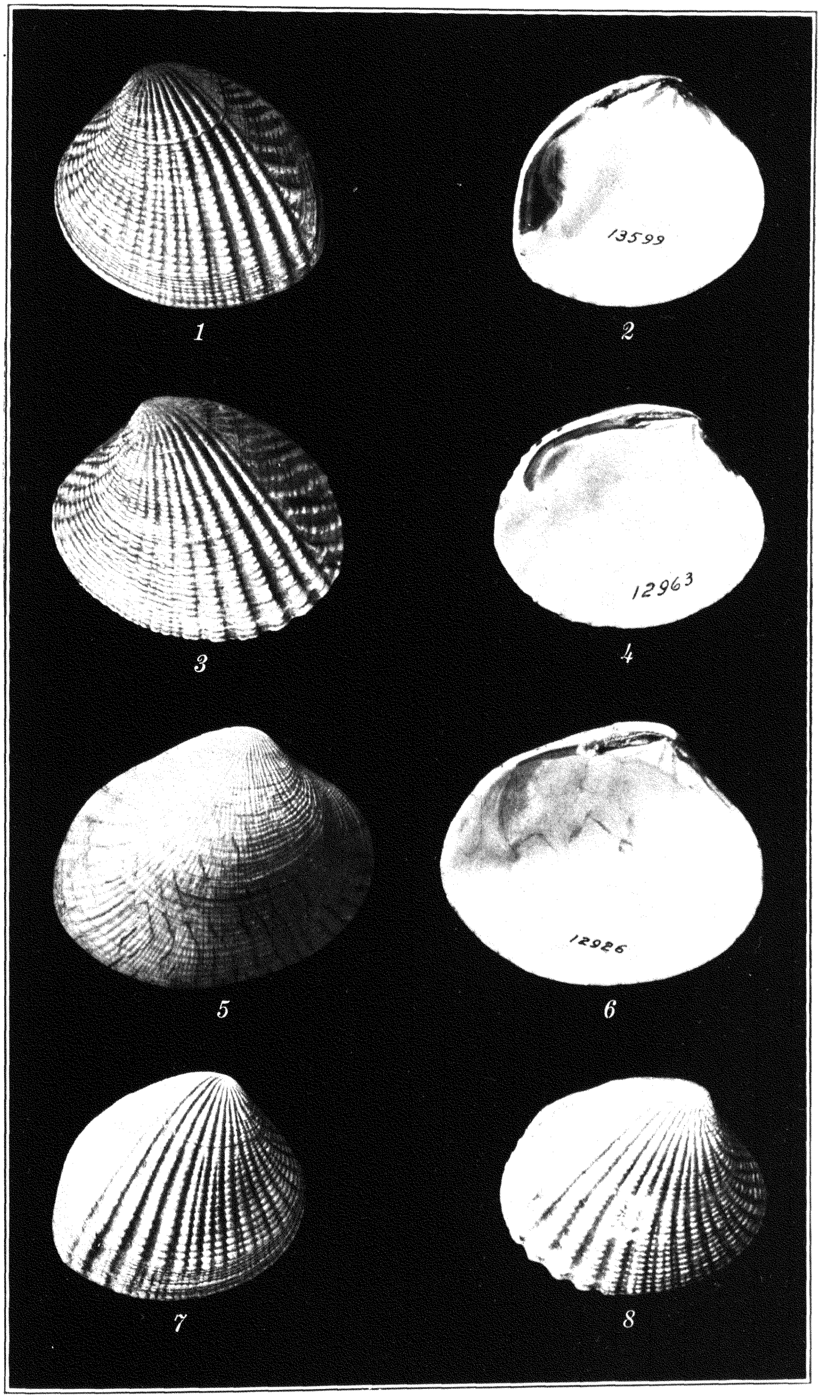

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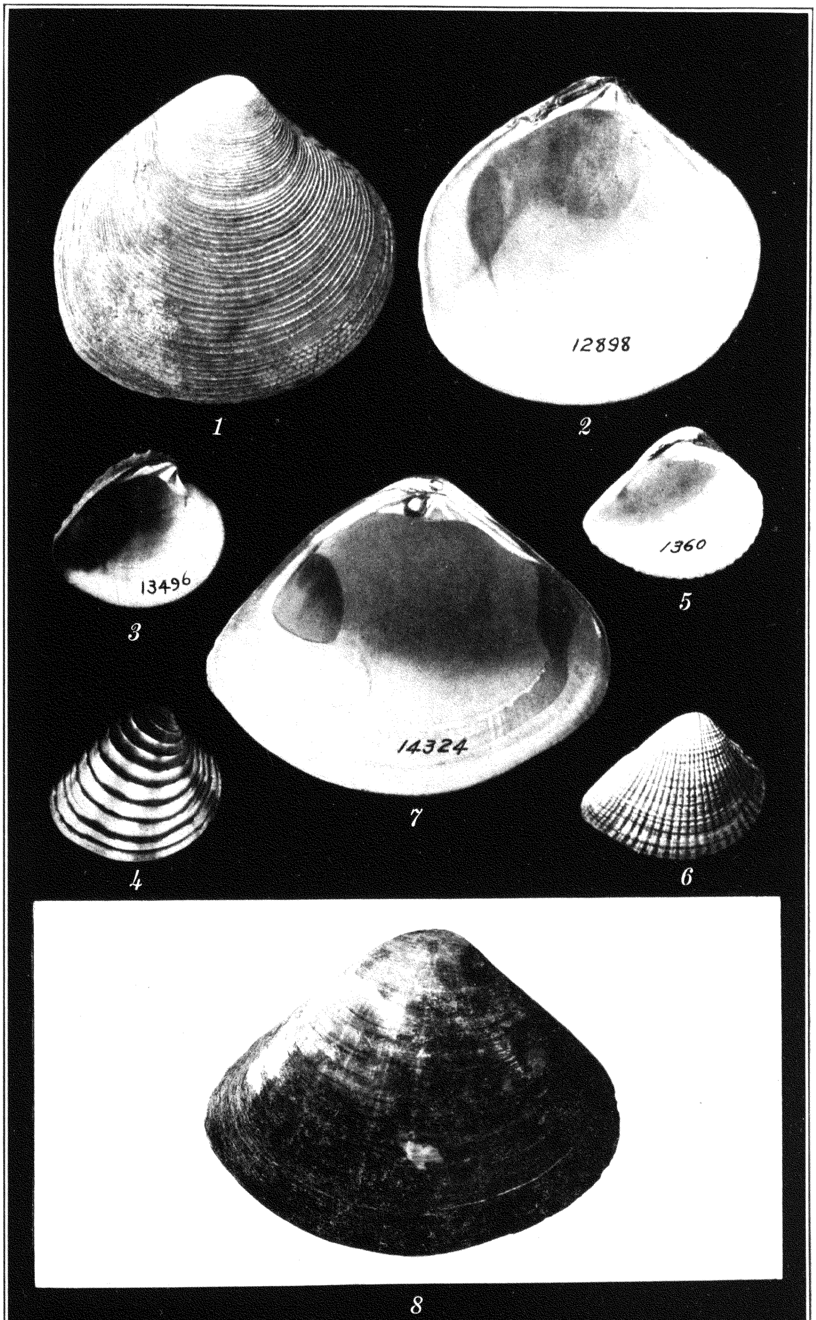

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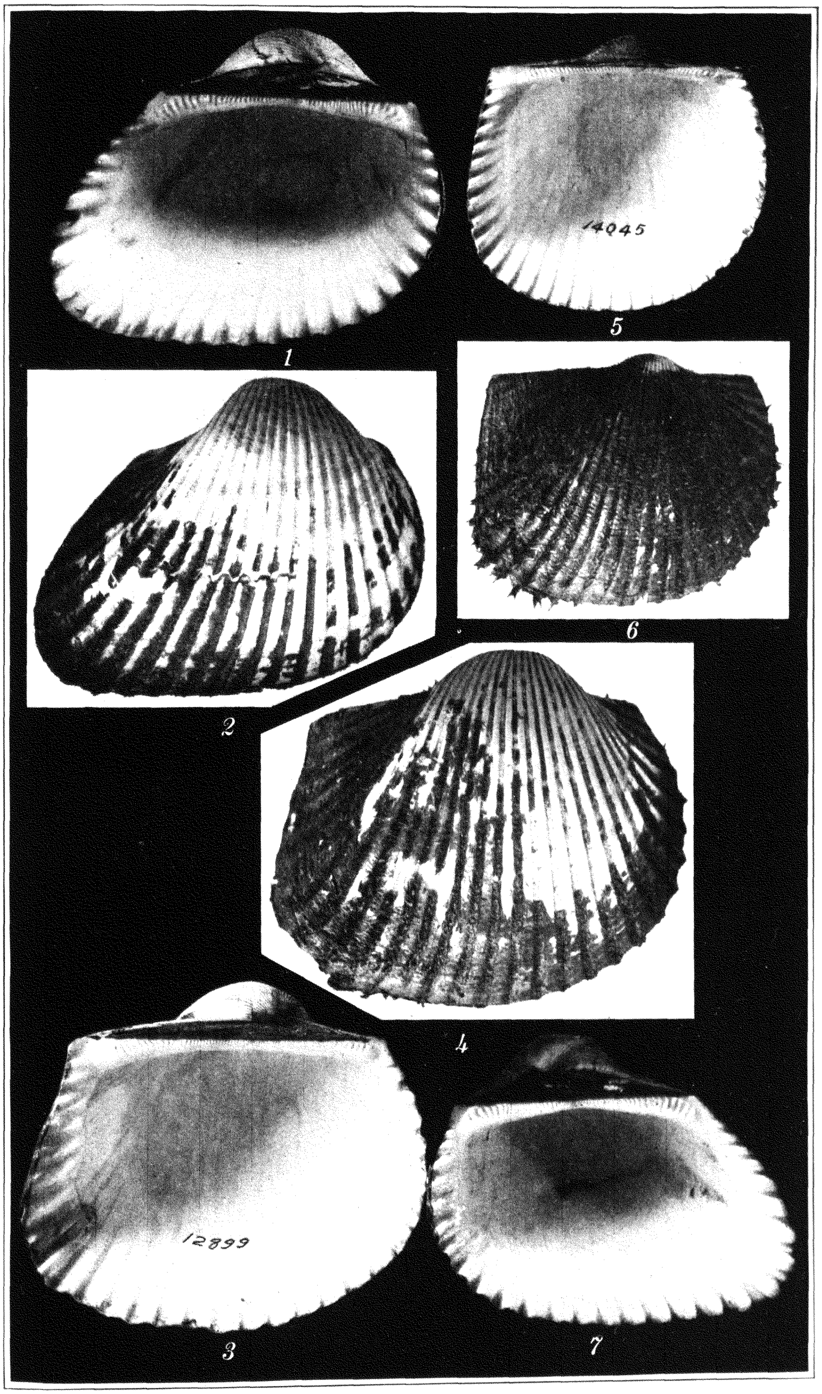

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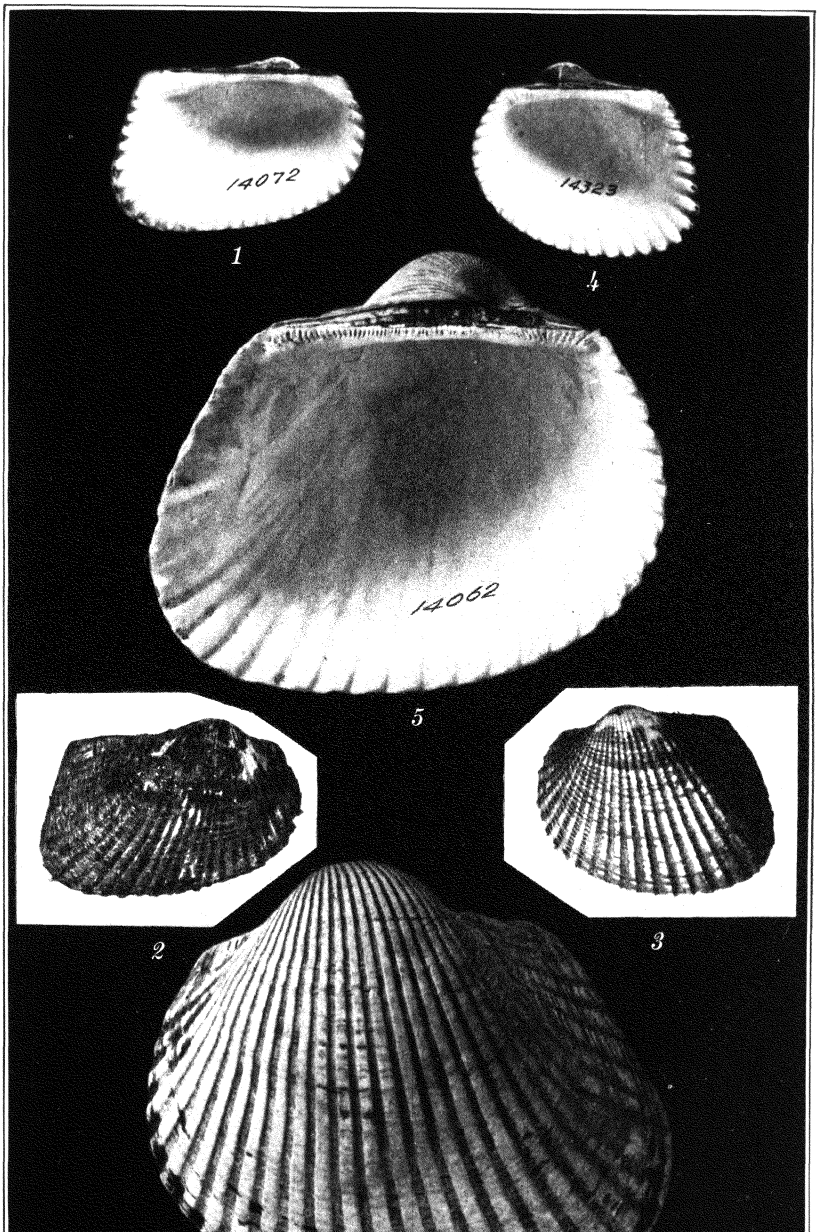

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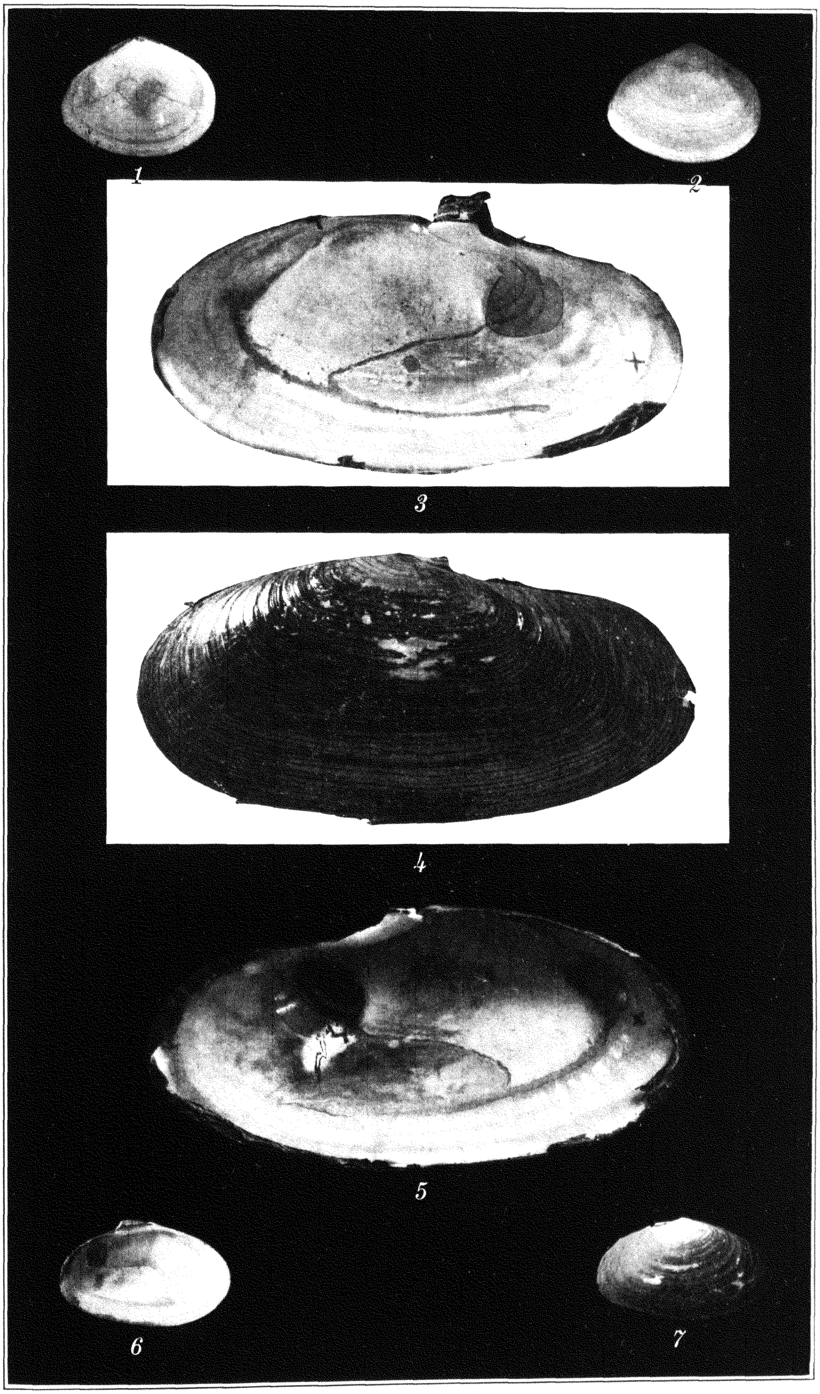

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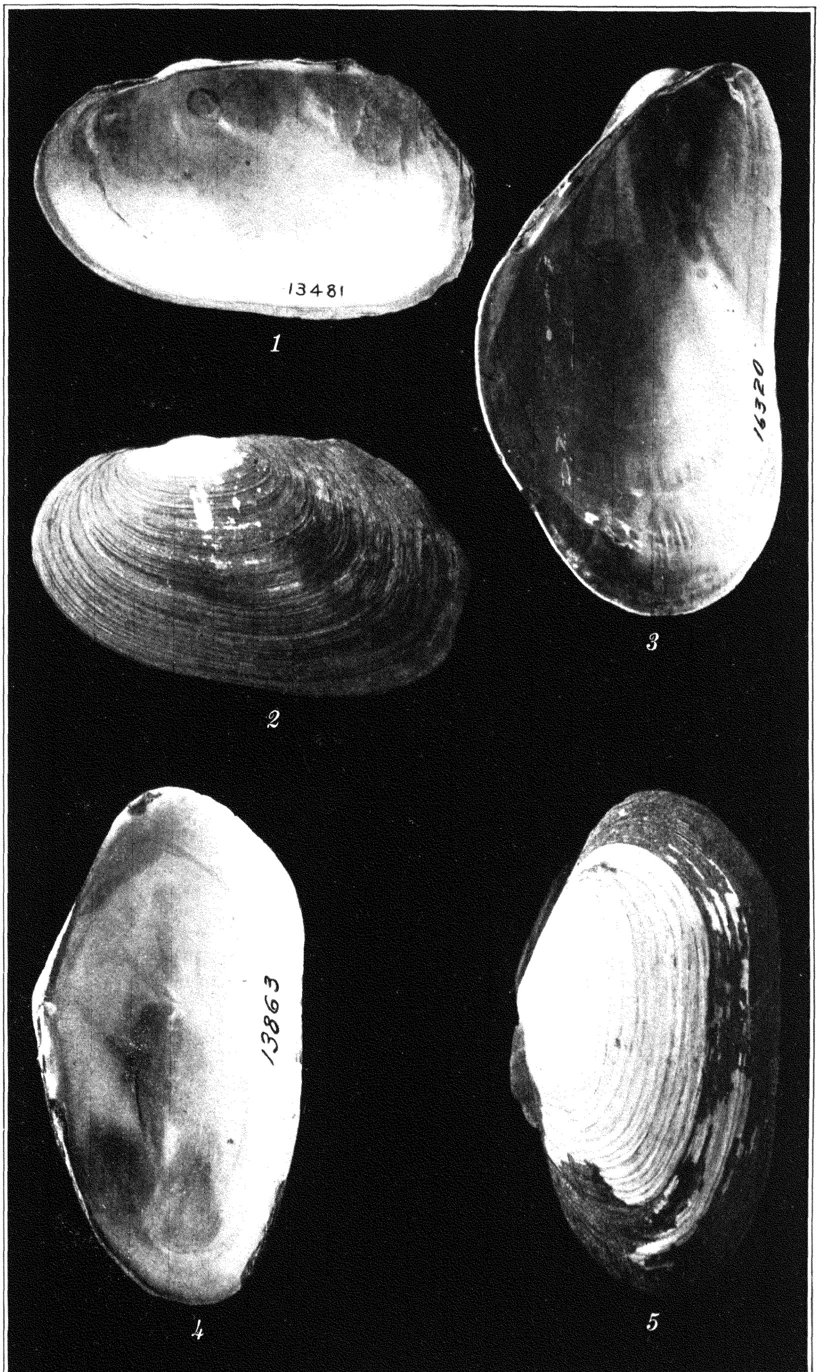

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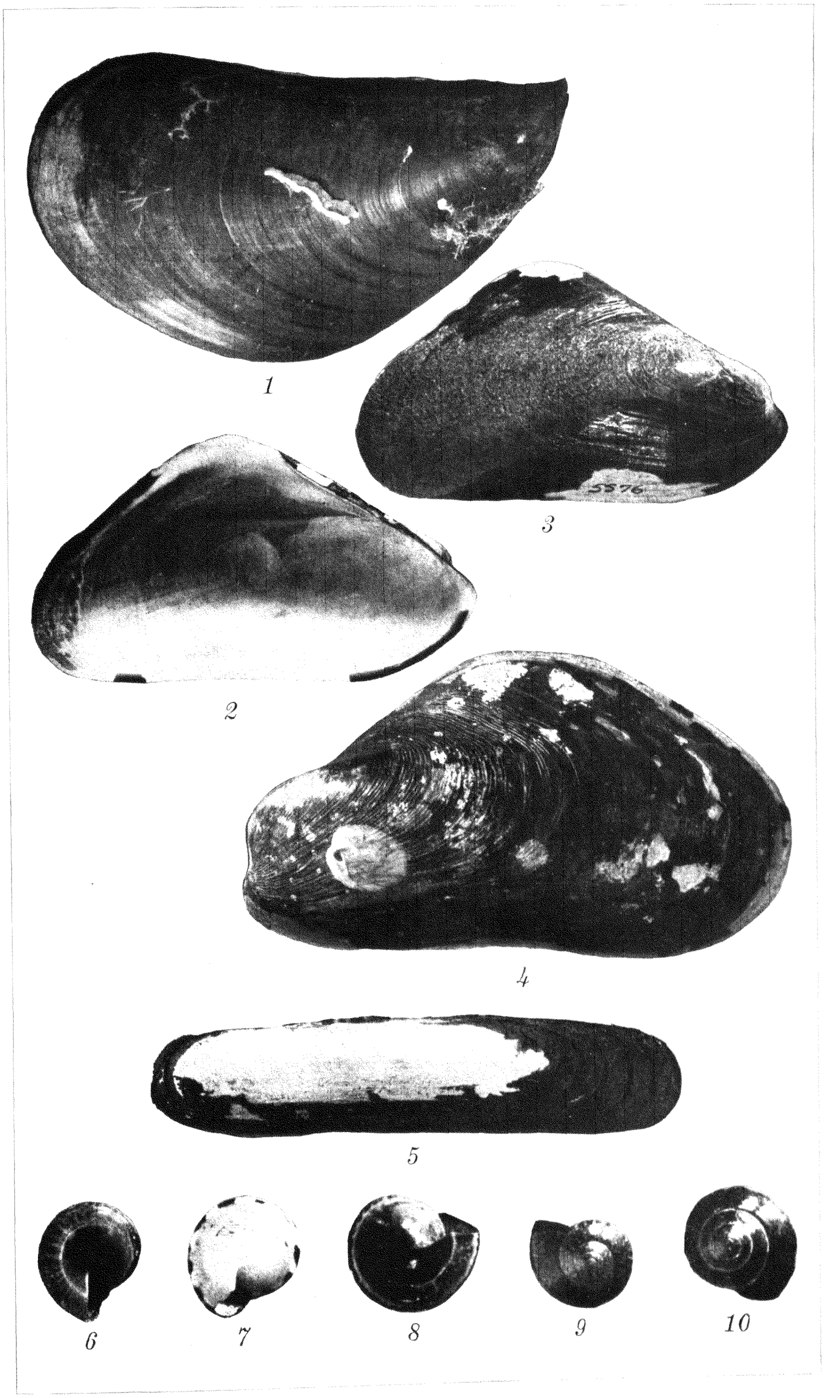


PLATE 11.

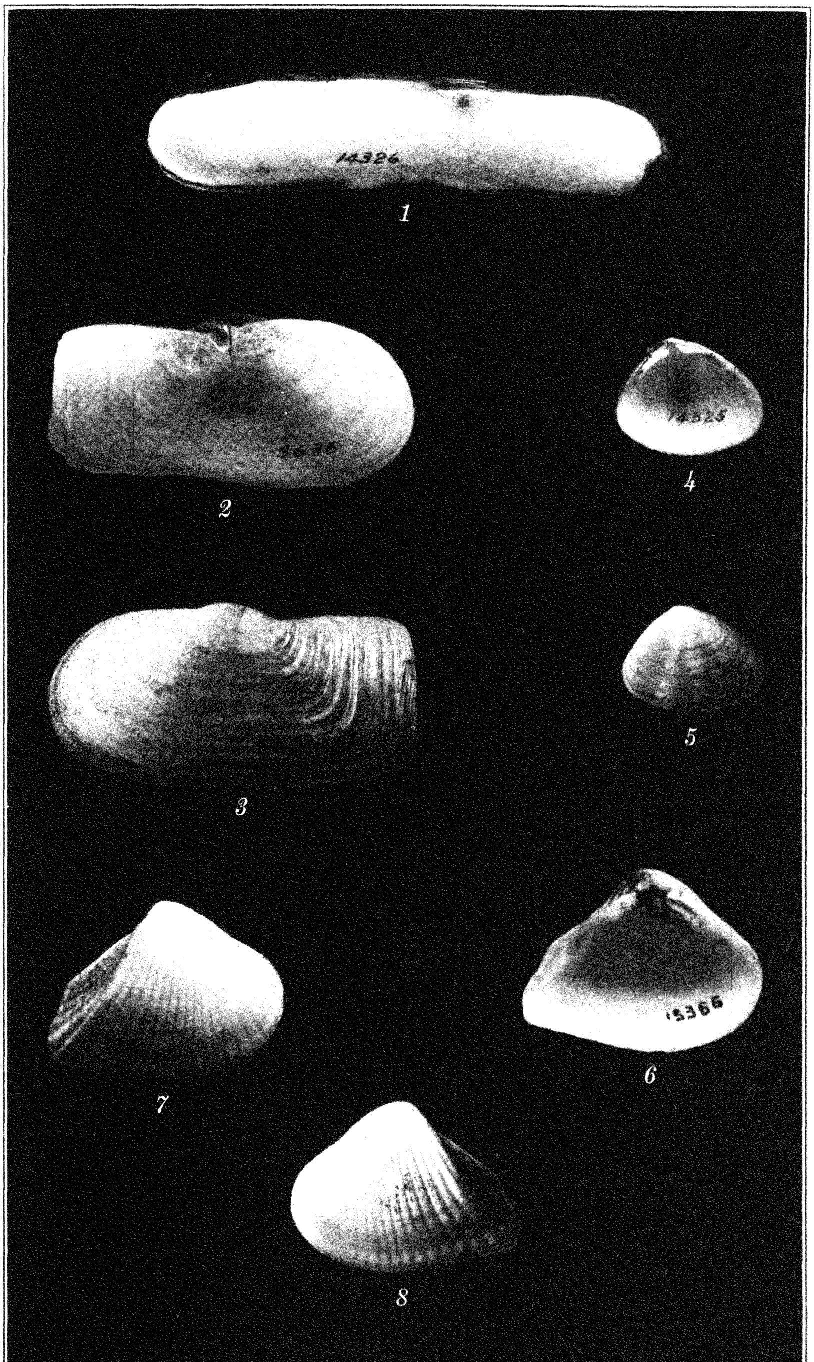


PLATE 12.

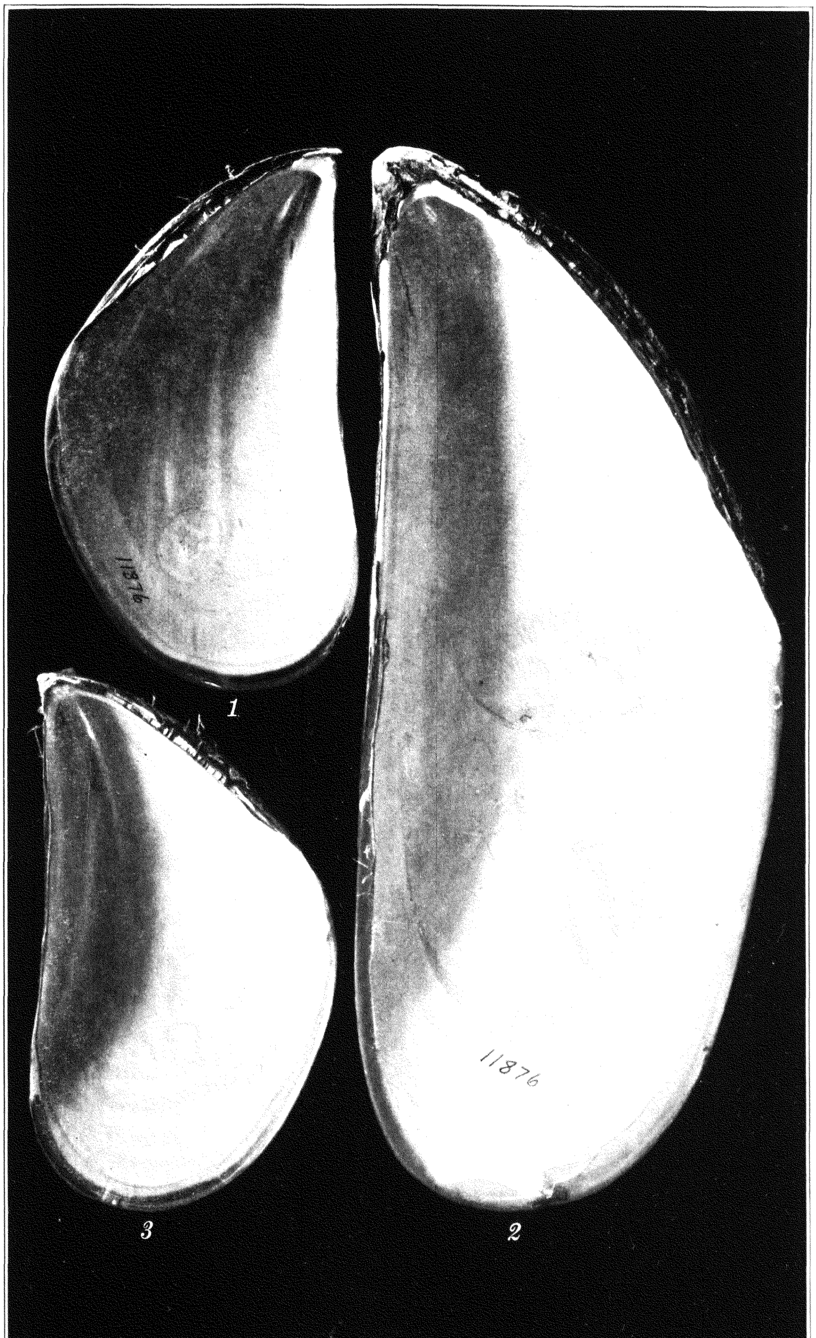
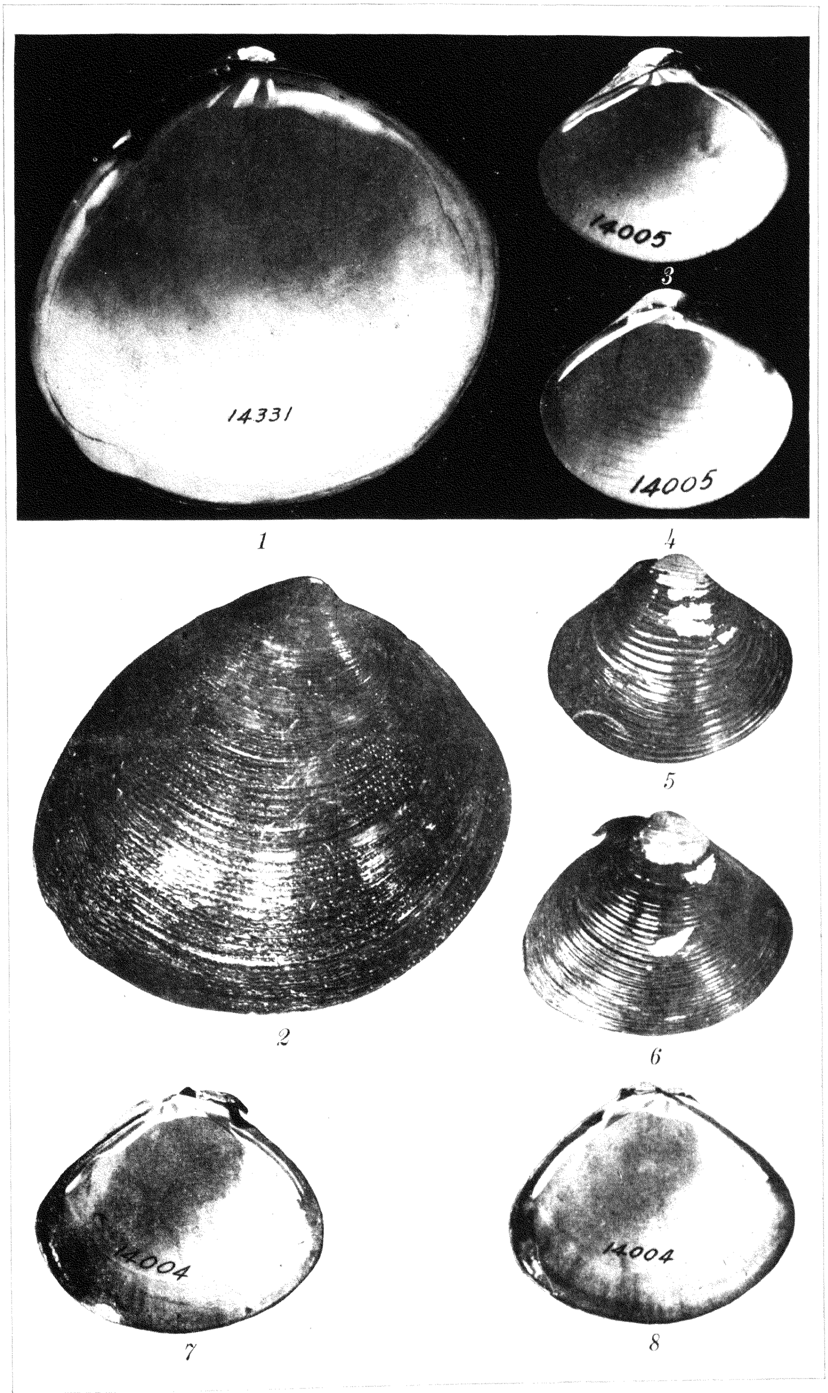


PLATE 13.



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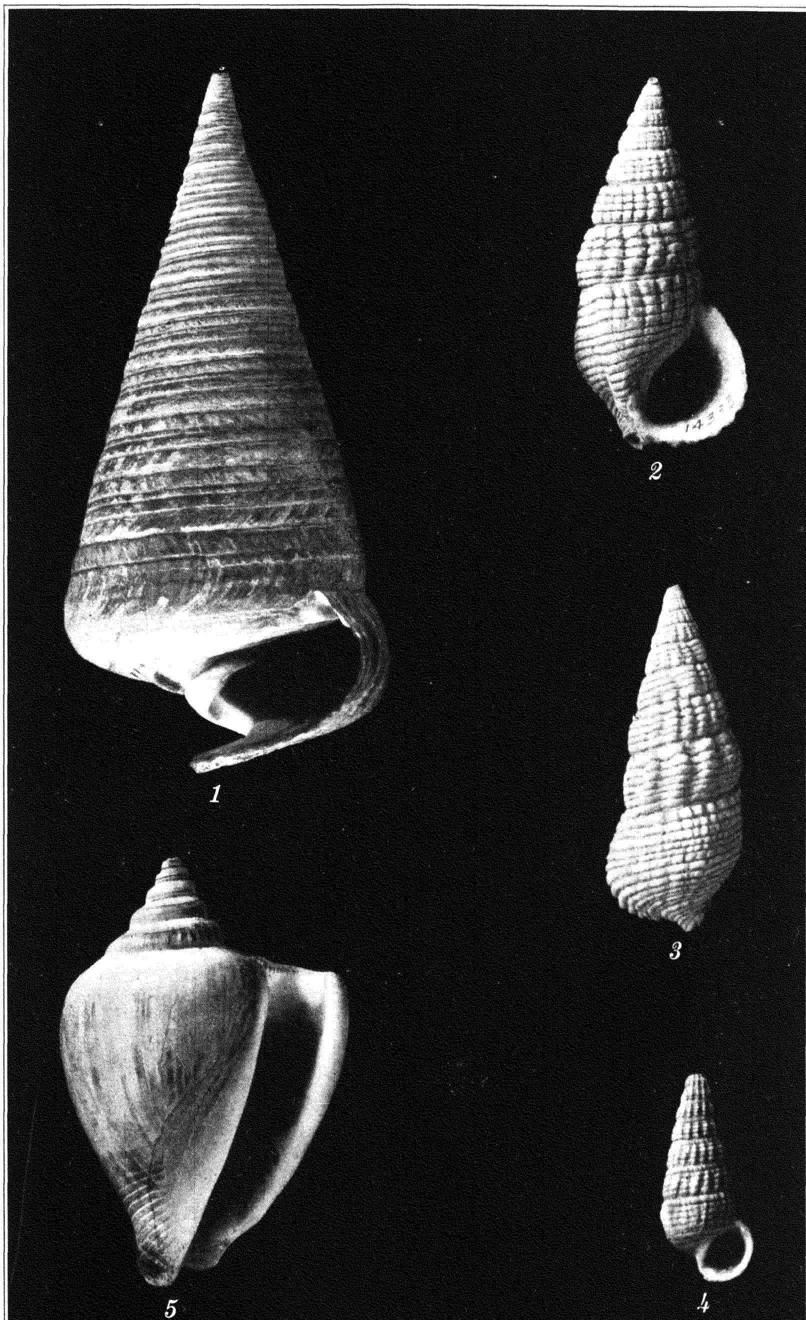
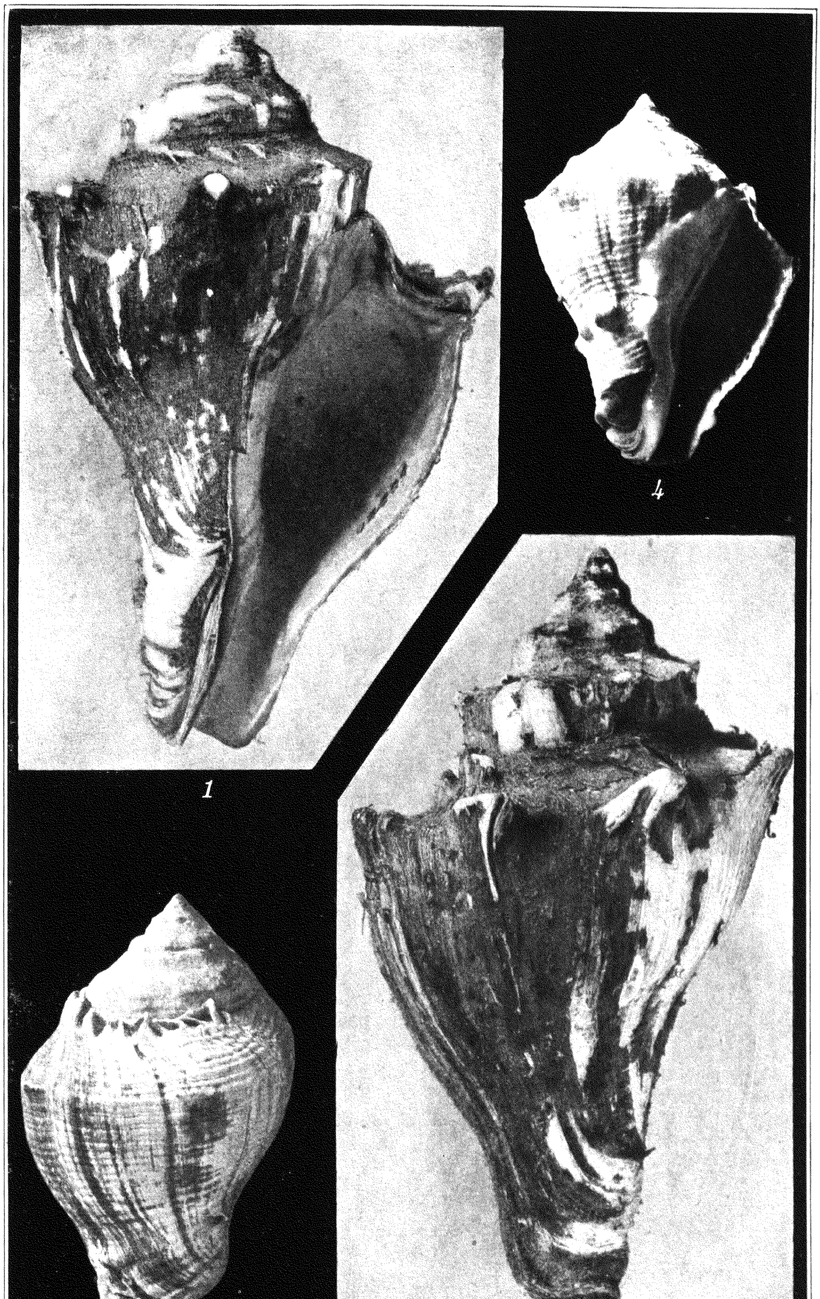


PLATE 15.



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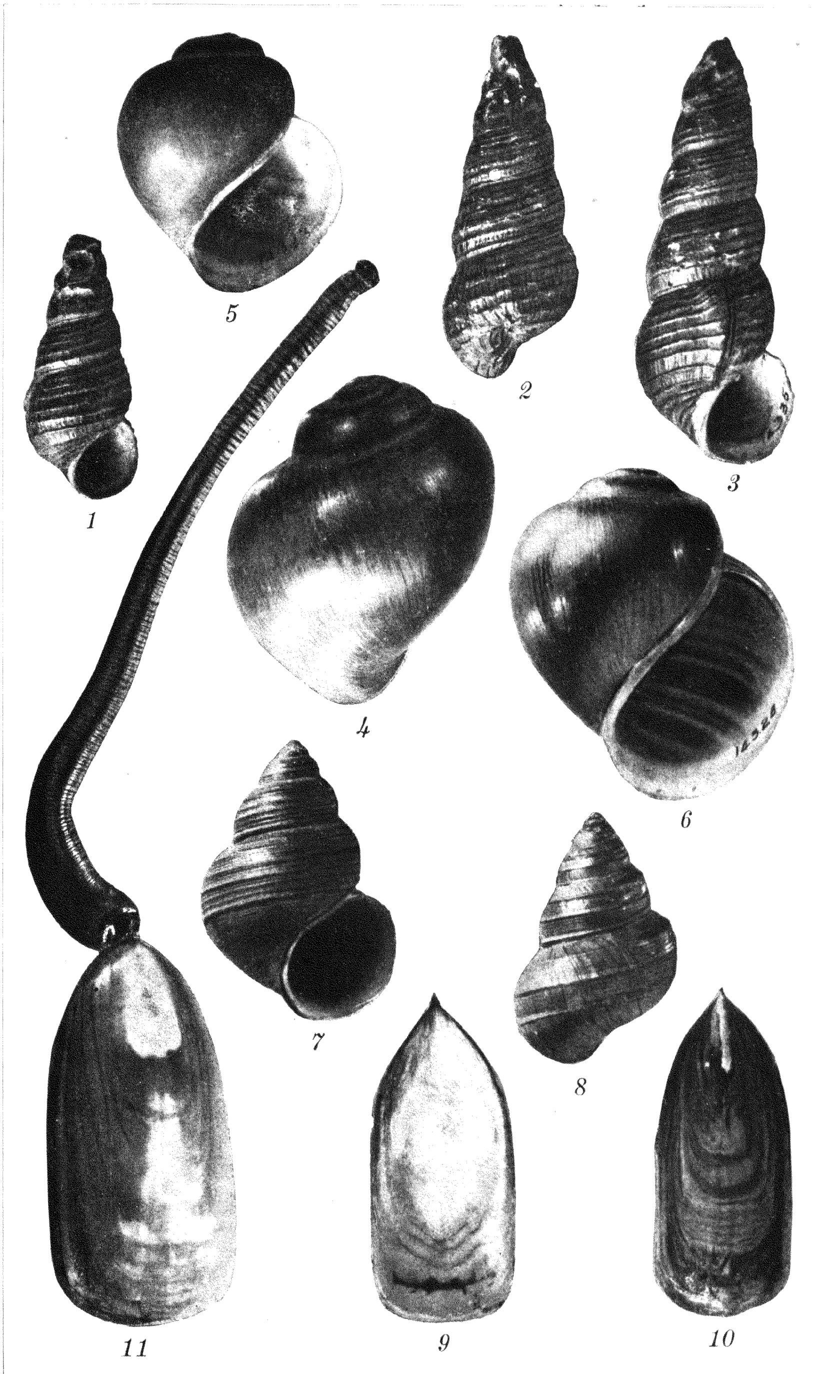

PLATE 17.

1

2

PLATE 18.

PHILIPPINE ALCYONARIA

THE FAMILIES CORNULARIIDÆ AND XENIIDÆ

By HILARIO A. ROXAS

Professor of Zoölogy, University of the Philippines, Manila

FOUR PLATES

In 1912 to 1914 many littoral marine animals were collected in various parts of the Philippine Archipelago through the efforts of members of the Department of Zoölogy, University of the Philippines. The most important localities were Puerto Galera Bay, Sabang Cove, and Calapan, Mindoro Island; Taytay Bay and neighboring small islands near the northern part of Palawan; the shallow regions around Cebu and Bantayan Islands; Mariveles, Bataan Province, at the entrance to Manila Bay; and Legaspi Bay, southern Luzon. The greatest part of this collection was alcyonarian material, some of which was worked out by Light (1913–15), but most of the alcyonarians were sent to Prof. W. Kükenthal, then at the University of Breslau. Small portions were worked out by J. Moser (1919), H. Lüttschwager (1922), and K. Kolonko (1926). After the death of Professor Kükenthal, all the Philippine specimens were transferred to the zoölogical museum of Berlin University and they are there now. When the present writer was sent to Europe for alcyonarian study he had the opportunity of examining all these specimens, the types of previously described Philippine species, and types from other parts of the world, and is thus in a position to deal with them more or less intimately.

The present paper on Philippine Alcyonaria was prepared under the joint auspices of the University of the Philippines and the John Simon Memorial Foundation and is based on collections taken by the writer to Europe in 1931–32. In addition to his gratitude to the University and the Guggenheim Foundation, the author wishes to express his thanks to the authorities of the Berlin and Breslau Museums for their permission to examine their excellent collections and for extending facilities for working. Special mention should be made of the help of Prof. J.

Moser during the preparation of this paper for which the writer is deeply indebted.

THE ALCYONARIANS

The classification of the alcyonarians has been the subject of much controversy for a long time. In recent years, Kükenthal (1925) divided the Octocorallia, a subclass of the Anthozoa, into three orders only; namely, Alcyonaria, Gorgonaria, and Pennatularia, with the families Telestidæ and Helioporidæ under Alcyonaria. As most workers are now agreed on the uniqueness of the anatomy of these two families they should be given separate ranks. This was done by Hickson (1930), who proposed another system of classification. He gave Alcyonaria the rank of a subclass and placed under it six orders; namely, Stolonifera, Telestacea, Alcyonacea, Coenothecalia (family Helioporidæ), Gorgonacea, and Pennatulacea. While the latter system has its merits in that it separates the Telestacea and the Coenothecalia from the Alcyonacea, it still retains them under the Alcyonaria. It is believed that it is better to retain Octocorallia as a subclass and divide it into five orders; namely, Alcyonaria, Telestaria, Coenothecalia, Gorgonaria, and Pennatularia.

While I have great respect for the opinion of the eminent English worker, Professor Hickson, who for the last forty-six years has done much to increase knowledge of the alcyonarians, and while I shall follow him in many instances, I cannot see how both Clavulariidæ and Cornulariidæ can be used as separate families as he proposes. It seems that Cornulariidæ, being the older name, should be retained as the family name and that, at most, it should be divided into two subfamilies; namely, Cornulariinæ and Clavulariinæ. With Telestidæ and Helioporidæ removed from the Alcyonaria, this should be divided as follows:

- Subclass Octocorallia.
  - Order Alcyonaria.
    - Suborder Stolonifera.
      - Family Cornulariidæ.
        - Subfamily Cornulariinæ.
        - Subfamily Clavulariinæ.
      - Family Tubiporidæ.
    - Suborder Alcyonacea.
      - Family Xeniidæ.
      - Family Alcyoniidæ.
      - Family Nephthyidæ.
      - Family Siphonogorgiidæ.
      - Family Fasciculariidæ.

The order should be diagnosed as follows: Alcyonaria are colonial sessile Octocorallia without an axial skeleton and with or without polyp dimorphism. Between the ectoderm and the endoderm is a mesoglœal mass which contains skeletal elements in the form of separate or compact sclerites or other hornlike bodies. Colony formation results from budding of new polyps from small canals, the solenia, which connect the gastral cavities of the older polyps. These canals may be single and may connect the polyps at different levels above the base, or they may form large groups, each called a stolon, which, at the base, form encrusting plates or strands. Out of the cœnenchymal mass extend the free portions of the polyps, which often are also retractile into the cœnenchymal mass.

The alcyonarians fall naturally into two main groups or suborders; namely, the Stolonifera, in which the mesoglœa of the colony is poorly developed so that the polyps, including the anthostele and the anthocodia, stand out separately and are connected only by a thin basal, creeping membrane or strand, or also by transverse bridges above the base; and the Alcyonacea, in which the mesoglœa is highly developed, forming a common mass or syndete around the anthosteles of all the polyps composing the colony. In the Alcyonacea, the free portions of the zooids, the anthocodiæ, collectively form the apodete of Bourne (1900). The limit of 6 mm thickness of the stolon set by Hickson to separate the Stolonifera from the Alcyonacea appears to me rather mechanical. I believe that it is the relative thickness of the stolon in proportion to the size of the anthocodiæ that should be considered. For this reason, it is always best to base the diagnosis, as much as possible, on living animals or on specimens that have been properly made to expand before fixation. One good instance where this is necessary is in the case of *Sympodium*. The English workers, including Hickson (1930) and Thomson and Dean (1931) have it under Stolonifera, Molander (1921) places it under Alcyoniidæ of the Alcyonacea, and Kükenthal places it under the Xeniidæ. The only form of this genus with which I am acquainted is *S. coeruleum* Ehrenberg. If the distinction between Stolonifera and Alcyonacea must be preserved, as Hickson wishes it to be, then *Sympodium coeruleum* should be included under the latter. In this species the thickness of the stolon is great in proportion to the size of the anthocodia, and a creeping but fleshy syndete is present. The absence of the filaments from the ventral and lateral mesenteries, however, as

well as the typical, oval biscuit, disc-shaped sclerites places it in the Xeniidæ, rather than in the Alcyoniidæ as Molander holds.

The limits of the suborders being established, it should not be difficult to divide each into smaller groups.

Key to the suborders, families, and subfamilies of the Alcyonaria.

*a*¹. Anthostele of zooids not united through a common cœnenchymal mass, but only through a transverse or creeping stolon or thin basal membrane .... Suborder STOLONIFERA.
  *b*¹. Sclerites, when present, widely separate .... Family CORNULARIIDÆ.
    *c*¹. Basal portions of zooids protected by horny sheath; sclerites absent .... Subfamily CORNULARIINÆ.
    *c*². Basal portions of zooids without horny sheath; sclerites present. Subfamily CLAVULARIINÆ.
  *b*². Sclerites compact to form cylinders and plates. Family TUBIPORIDÆ.
*a*². Anthostele of zooids united by a common cœnenchymal mass. Suborder ALCYONACEA.
  *b*¹. Filaments absent from the six ventral and lateral mesenteries; sclerites biscuit-form or disc-shaped........ Family XENIIDÆ.
  *b*². Filaments present in all mesenteries; sclerites in the form of sticks, spindles, clubs, double spindles, barrels, and double stars, or their modifications.
    *c*¹. Zooids (anthocodia) distributed uniformly on upper surface of colony; basic form of sclerites girdled sticks or spindles. Family ALCYONIIDÆ.
    *c*². Zooids united in groups of different sizes; basic form of sclerites warty spindles.
      *d*¹. Polyp-bearing portion of colony (apodete) not retractile into sterile stalk (syndete).
        *e*¹. Stalk sclerites uniformly distributed throughout. Family NEPHTHYIDÆ.
        *e*². Stalk sclerites accumulated axislike, in inner portion of cœnenchyme .... Family SIPHONOGORGIIDÆ.
      *d*². Entire polyp-bearing portion of colony (apodete) partly or wholly retractile into the stalk (syndete). Family FASCICULARIIDÆ.

Suborder STOLONIFERA Hickson

"Colonial Alcyonaria with a membranous or ribbonlike stolon. Mesoglœa poorly developed. Polyps either entirely free from one another, excepting at their bases, or connected by horizontal platforms or connecting tubes." (Hickson.)

Family CORNULARIIDÆ Dana

Cornulariidæ DANA, Zoophytes (1846) 627; MILNE-EDWARDS, Hist. Nat. des Corall. 1 (1857) 104; WRIGHT and STUDER, Challenger Report 31 (1889) 252; STUDER, Alcyon. de l'Hirondelle (1901) 11; KÜKENTHAL, Korallthiere des roten Meeres (1904) 39; Alcyonacea

der Tiefsee-Expedition **30** (1906) 8; MOLANDER, Kungl. Sv. Vet. Akad. Handl. **51** (1915) 24.

Cornularidæ v. KOCH, Alcyon. Golfes Neapel, Mitt. Zool. Stat. Neapel **9** (1891) 653.

Clavulariidæ HICKSON, Rev. Alcyon. Stolonifera (1894) 329; SCHENK, Clavulariiden, Xeniiden u. Alcyoniiden von Ternate (1896) 43; MAY, Jena Zeitschr. f. Naturw. **33** (1899) 27.

The family Cornulariidæ was established by Dana in 1846; he included under it only the genus *Cornularia* Lamarck, but remarked that *Clavularia* of Quoy and Gaimard, when properly worked out, should also belong to his new family. From the time of Dana to the present there are no less than twenty-six genera that have been described belonging to the family. These genera, arranged in the chronological order of their establishment, are as follows:

Anthelia Lamarck (1816).
Clavularia Quoy and Gaimard (1830).
Sympodium Ehrenberg (1834).
Rhizoxenia Ehrenberg (1834).
Cornularia Lamarck (1836).
Evagora Philippi (1842).
Sarcodictyon Forbes (1847).
Telesto Lamarck (1857).
Coelogorgia Milne-Edwards (1857).
Haimea Milne-Edwards (1857).
Erythropodium Kölliker (1865).
Hartea Wright (1865).
Cyathopodium Verrill (1868).
Gymnosarca Kent (1870).
Callipodium Verrill (1871).
Anthopodium Verrill (1872).
Cornulariella Verrill (1874).
Trachythela Verrill (1874).
Sclerenthelia Studer (1878).
Stereosoma Hickson (1894).
Rolandia de Lacaze Duthiers (1900).
Hicksonia Delage and Herouard (1901).
Pachyclavularia Roule (1908).
Acrossota Bourne (1914).
Parerythropodium Kükenthal (1916).
Solenopodium Kükenthal (1916).

Haimea Milne-Edwards and *Hartea* Wright are supposed to be noncolonial, primitive alcyonarians; but as there is no concrete proof of the existence of these forms, they being possibly nothing but young forms of other species, the genera should be discarded. *Telesto* Lamarck, *Coelogorgia* Milne-Edwards, and *Pseudogorgia* are now placed under a separate order, Telestidæ. The genera *Erythropodium* Kölliker, *Pachyclavularia* Roule, and *Evogora* Philippi have been assigned by Kükenthal (1916) and Molander (1929) to the family Briareidæ of the Gorgonaria, although Hickson (1930) leaves *Erythropodium* and *Pachyclavularia* in the Clavulariidæ. *Rhizoxenia,* according to Kükenthal (1916), should be discarded, and its species should be distributed among *Anthelia* and *Evagora.* *Stereosoma,* according to Light, Schenk, and Kükenthal, is inseparable from *Anthelia.*

Hicksonia is of course *Clavularia*, and the genus should be discarded as soon as possible to avoid confusion in nomenclature. Light says that species of *Rhizoxenia* whose polyps are entirely retractile should be reckoned under *Sympodium*. *Scleranthelia* is sometimes considered a cornulariid (Studer 1878, Versluys 1907, S. Thomson 1921) and sometimes a telestid (May, 1899, Kükenthal 1906). *Sarcodictyon*, according to Kükenthal (1916), is identical with *Evagora*, the latter also considered by him as being near *Alcyonium*. Hickson (1930) retains *Sarcodictyon* in the Clavulariidæ. *Gymnosarca*, *Anthopodium*, and *Cyathopodium* have been so insufficiently described that it becomes hard to place them. Discarding the above generic names, there remain eleven to be accounted for; namely, *Anthelia*, *Clavularia*, *Sympodium*, *Cornularia*, *Callipodium*, *Cornulariella*, *Trachytela*, *Rolandia*, *Acrossota*, *Parerythropodium*, and *Solenopodium*. According to Hickson *Anthelia* should be merged with *Clavularia* and only the latter name should be retained. We are, however, reckoning *Anthelia* here as a distinct genus. *Sympodium* in this paper is being treated as a member of the Xeniidæ. *Cornulariella* Verrill has a thin basal stolon or membrane and should probably be retained in the family. *Callipodium* is also a form with creeping stolon over shells of mollusks, and the genus apparently is a valid one. As I have no personal knowledge of *Rolandia*, *Acrossota*, *Trachytela*, *Parerythropodium*, and *Solenopodium*, I shall confine my attention to the Philippine forms of *Cornularia*, *Clavularia*, and *Anthelia*, as belonging to the family Cornulariidæ. I give the following diagnosis of the family:

The individual polyps are united mostly at the base by a creeping stolon or basal plate into which the polyps are never retractile. The solenia may form a stolon above and connect the various polyps at different levels above the base of the colony. Thus, new polyps may arise either from the colony base or from the transverse stolon. The sclerites are long, slender, sparsely warted spindles, sticks, and clubs; also weakly warted and small, flat or dumb-bell-shaped discs. In some forms sclerites may be absent.

The three genera of the family represented in our collection can be told apart by the use of the following key:

Key to three genera of the Cornulariidæ.

a^1. Basal part of polyps protected by a horny sheath; sclerites absent. *Cornularia* Lamarck.

a^2. Basal part without horny secretion, sclerites present.

b[1]. Polyps have calyx (anthostele) into which the distal moiety (anthocodia) can be retracted; pronounced difference in sclerites of upper and lower portion of polyps............ *Clavularia* Quoy and Gaimard.

b[2]. Polyps without a distinct calyx (anthostele) into which distal moiety (anthocodia) can be retracted; sclerites all similar. *Anthelia* Lamarck.

Genus CORNULARIA Lamarck

Cornularia LAMARCK, Hist. nat. Anim. sans Vertebres (1816) 127; CUVIER, Regne Animal, Zoophytes (1850) 121, pl. 65, fig. 3; SCHWEUGGER, Hand. d. Naturges. (1825) 425; BLAINVILLE, Manual d'actinologie (1834) 499; MILNE-EDWARDS and HAIME, Hist. Nat. des Corall. 1 (1857) 105.

The genus *Cornularia* was established by Lamarck in 1836 when he described an animal that he called *Cornularia rugosa*. This form, however, had been described by Pallas as *Tubularia cornucopiæ* and thus should be called *Cornularia cornucopiæ* (Lamarck). From the time of Lamarck four valid species of *Cornularia* have been described; namely, *C. cornucopiæ* (Lamarck) from the Mediterranean, *C. crassa* Milne-Edwards from the coast of Algeria, *C. australis* Busk from the coast of Australia, and *C. minuta* Light from the Philippines.

I have seen only one specimen of this genus and I am giving the following diagnosis from a review of the literature:

Cornulariids whose small polyps are united at the base by a slender, cylindrical, creeping stolon which contains usually only a single endodermal canal. Polyps are devoid of sclerites, the stolon and the base of polyps protected by a horny secretion. The distal moiety of the polyps can be partially retracted into the proximal portion, which is surrounded by the horny secretion.

The lone material described by Light (1915) and named *C. minuta* was obtained from Legaspi Bay, Luzon, "growing on colonies of *Siphonogorgia variabilis* Hickson." No. C–2457, University of the Philippines zoölogical collection. The Philippine example of *Cornularia* is not typical of the genus as the basal stolon contains more than one endodermal cavity. Light states that this form is more or less intermediate between *Cornularia* and *Clavularia*. Molander (1929) revised the diagnosis of the genus so as to include *C. minuta*, which has more than one endodermal cavity in the stolon.

CORNULARIA MINUTA Light.

Cornularia minuta LIGHT, Philip. Journ. Sci. § D 10 (1915) 203.

"The very minute colonies are attached to the surface of support by the creeping, anastomosing, threadlike stolons. The

polyps arise from the stolons at irregular intervals, and when fully expanded have a maximum length of about 2.5 millimeters, including the tentacles, and a minimum diameter of from 0.3 to 0.4 millimeter just below the tentacles. Each polyp is connected with one or more stolons, each of which contains two or more endodermal canals lying in a thick homogenous mesogloea. These stolons are covered with a very thin, wrinkled, perisarc-like, horny envelope, an extension of which forms a cuplike covering for the basal portion of the polyps. The expanded polyps are slender, and the tentacles are about one third as long as the body of the polyp and bear on either side a single row of from 6 to 10 rather short, thick, cylindrical pinnules. When contracted, the distal portion of the polyp is retracted within the basal, horny covering, which is then coneshaped or beehive-like. There are no spicules." (Light.)

Genus CLAVULARIA Quoy and Gaimard

Clavularia QUOY and GAIMARD, Blainville Dict. Sci. Nat. (1830) 499, t. 60; MILNE-EDWARDS, Hist. Nat. des Corall. 1 (1857) 166; WRIGHT and STUDER, Challenger Report 31 (1889) 254; HICKSON, Revision Alcyon. Stolonifera, Trans. Zoöl. Soc. London 13 (1894); SCHENK, Clavulariiden etc. from Ternate (1896) 44; MAY, Jena Zeitschr. f. Naturw. 33 (1899) 40; KUKENTHAL, Deutschen Tiefsee-Expedition 30 (1906) 15; MOLANDER, Kungl. Sv. Vet. Akad. Handl. 51 (1915) 28.

Hicksonia DELAGE and HEROUARD, Trait's de Zoologie Concrete 2 pt. 2 (1901).

The genus *Clavularia* was established by Quoy and Gaimard in 1830 and confirmed by them after the return of the *Astrolabe*. In 1895, Hickson extended the limits of the genus and included in it *Anthelia* Lamarck, *Rhizoxenia* Ehrenberg, *Sarcodictyon* Forbes, *Gymnosarca* Kent, and *Cornulariella* Verrill; at the same time he created a new genus, *Stereosoma*. According to Schenk and later to May the genus *Stereosoma* should be also included in the large genus *Clavularia*. After examining Philippine material of *Clavularia* and *Anthelia*, I am of the opinion that Kükenthal, Light, and Molander are correct in their conclusion that enough differences exist between the two genera to warrant their separation. I see no reason for discarding either *Clavularia* or *Anthelia* as proposed by Hickson (1930). I have had no opportunity to examine examples of the genus *Stereosoma* Hickson and therefore cannot judge its validity, but I am convinced that the genus *Hicksonia* introduced by Delage and Herouard (1901) and by Dean (1927) cannot be accepted, as the

species they used as the type, *Hicksonia viridis*, is also the type of *Clavularia*. The following is a definition of the genus:

Clavularia includes cornulariids whose polyps are united by a basal or transverse stolon or membranous basal plate containing a network of canals. The polyps are usually divided into a basal nonretractile calyx (anthostele) and a distal moiety (anthocodia) that can be withdrawn into the upper portion of the calyx. The sclerites of the lower portion of the polyps are large, strong spindles, sticks, and clubs heavily warted and arranged in distinct rows, and are always different in size and shape from those of the upper portion. Polyps and stolon are without any horny secretion.

With the above definition, three Philippine forms belong to this genus.

CLAVULARIA VIRIDIS Quoy and Gaimard.

Clavularia viridis QUOY and GAIMARD, Voy. de l'Astrolabe Zooph. 4 (1883); MILNE-EDWARDS and HAIME, Hist. Nat. des Corall. 1 (1857) 107; HICKSON, Proc. Royal Soc. 40 (1886) 322–325; WRIGHT and STUDER, Challenger Report, Zoöl. 31 (1889) 297; HICKSON, Willey's Results pt. 4 (1900) 494.

Hicksonia viridis THOMSON and DEAN, Siboga Expedition 13d (1931) 14.

Numerous zooids arise from a creeping cylindrical or plate-like stolon; the latter, however, is never extensive. In addition, zooids are united by means of cylindrical transverse stolons at different levels of the calyx. Polyps vary in length even in one colony; they never extend straight up, but always grow at an angle with the substratum and slightly curved. Longer polyps are either tortuous or bent at points where transverse stolons arise from them. Noncontractile portion of zooids, the calyx, as much as 60 mm high, although the majority are 20 to 30 mm long. They vary from 4 to 6 mm in diameter; the apical portion is always slightly distended and marked with eight longitudinal furrows. Introvertible neck and crown, excluding tentacles, 10 to 14 mm long and when inside calyx, 2 to 4 mm in diameter. Tentacles 5 to 6 mm long with slightly flattened axis 0.7 to 0.8 mm wide at base. Pinnules short and stout, one row on either side of axis; nine to eleven pinnules in a row. Sclerites of calyx and stolon long spindles, 1.3 mm long and 0.16 mm wide at middle with prominent projecting thorns. Polyp sclerites, which according to Hickson are absent in the type species of the genus, are present in the crown, neck, tentacles, and pinnules. These are flat, biscuitlike discs about 0.036 mm long and 0.0144 mm

wide, usually with a shallow constriction on either side. Base of calyx dirty creamy white. Upper portion of zooids yellowish green.

CLAVULARIA INFLATA Schenk var. LUZONIANA May.

Clavularia inflata SCHENK, Xeniiden und Alcyoniiden von Ternate. Franfurt a. M. (1896) S. 48.

Clavularia inflata var. *luzoniana* MAY, Jena Zeitschr. f. Naturw. 33 (1899) N. F., 44, t. 1, fig. 4; t. 5, fig. 1a, b.

Hicksonia köllikeri DEAN, Proc. Roy. Soc. Edin. 21 (1927).

From a very thin, hard and flat, platelike or creeping stolon numerous zooids arise very close to each other leaving almost no space between their basal portions. Nonretractile part of zooids in form of a calyx with a slightly distended upper portion marked with longitudinal furrows. Calyx 20 to 22 mm high with a diameter of 4 mm at base and 6 mm at upper swollen portion. Between calyx and introvertible portions is a neck which, in contracted condition, is about 3 mm in diameter. Introvertible crown, when contracted, about 5 mm long, tentacles not included. Tentacles solid looking, about 5 mm long and 2 mm wide at base, almost triangular in contracted specimens. Pinnules cover entire inner surface of tentacles, fingerlike with more or less rounded ends, and about 0.7 mm long and 0.16 mm in diameter at base.

Sclerites differ in different parts of zooids. In pinnules and tentacles they are elongate, flat, biscuitlike discs from 0.037 to 0.085 mm long and about 0.011 mm wide. At base of tentacles they are short, stout sticks with fine projections and forked at one end, 0.4 to 0.5 mm long and 0.08 to 0.09 mm wide. At crown, part inclosing tentacles when introverted, sclerites are long regular spindles with rather fine granulations, at most 0.96 mm long and 0.08 mm wide. These sclerites usualy lie in double rows, ten pairs in each double row. Below these are other spindles which lie more or less horizontally. The sclerites of calyx are also spindles about 1.6 mm long and 0.208 mm wide, with long but simple warts scattered irregularly on them. These lie close together, many times overlapping each other, making the calyx hard and brittle. Sclerites of stolon are also spicules but with coarser warting and of stouter build. These are up to 0.99 mm long and 0.09 mm wide. In addition, many sclerites of stolon are of very irregular shape or are branched at tips.

Stolon creamy yellow, calyx dirty yellowish green, the retractile portions deep green.

The type of this variety was obtained from Albay, Luzon, and is now in the Berlin Zoölogical Museum. This is the commonest species of *Clavularia* in the Philippines.

CLAVULARIA VIOLACEA Quoy and Gaimard.

Clavularia violacea QUOY and GAIMARD, Voy. de l'Astrolabe, Zoöl. 4 (1833) 262, pl. 21, figs. 13, 16; MILNE-EDWARDS and HAIME, Hist. Nat. des Corall. 1 (1857) 107; WRIGHT and STUDER, Challenger Report, Zool. 31 (1889) 297.

Numerous thickly set polyps arise from a much-branched, creeping stolon or platelike base. In certain instances the stolon may pass through crevices of dead corals so that the colony instead of being flat, becomes irregular in extent. Polyps are usually connected to each other only by basal stolon, but in certain cases two or three of them may have their basal portions united. Calyx of polyps between 7 and 13 mm high, crown not included, and 1.2 to 2 mm wide. Just below crown, calyx is slightly enlarged. Entire extent of calyx marked by irregular, fine indentations. Between calyx and introvertible portion of polyps is a neck about 1.5 mm high. Tentacles more or less cylindrical, 3 to 3.6 mm long and 0.4 to 0.6 mm wide. Pinnules tiny, rounded, and in one row on either side of tentacle. There are twenty-six to thirty pinnules in a row.

Introvertible parts of zooids without sclerites. Sclerites of stolon and calyx are spindles 0.2 to 0.6 mm long and 0.04 to 0.1 mm wide, with four to twelve whorls of tiny warts. Some sclerites are stouter in build, around 0.3 mm long and 0.12 mm wide, with much heavier warting. Many sclerites may be curved or otherwise deformed.

Calyx reddish violet due to color of sclerites. Introvertible portions dirty creamy white in preserved specimens.

This species has been recorded from Vaniko Island. Philippine material was collected from Mariveles, Luzon.

Genus ANTHELIA Savigny

Anthelia SAVIGNY, Description de l'Egypte; Histoire Naturelle, Supp. 1 (1817); EHRENBERG, Corallenthiere des roten Meeres (1834) 54; LAMARCK, Hist. Nat. Anim. sans Vertebres 2 (1836) 622; DANA, Exploring Expedition, Zooph. 7 (1846) 602; MILNE-EDWARDS and HAIME, Hist. Nat. des Corall. 1 (1857) 109; KÜKENTHAL, Alcyonacea, deutschen Tiefsee-Expedition 12 (1906) 10; MOLANDER, Alcyonacien von Madagascar, Arkiv. f. Zool. Kungl. Sv. Vet. Akad. Handl. 14 (1921) 2.

The genus *Anthelia* was first established by Savigny (1817) when he described a cornulariid alcyonacea which he called *A.*

glauca. The validity of the genus remained unquestioned until 1894, when Hickson in his revision of the Alcyonaria Stolonifera included in *Clavularia* all the animals that had been described under the genus *Anthelia*. Hickson's example was followed by Schenk (1896) and May (1899). Such a move is not warranted by our present knowledge of these animals. To the writer it appears that the genus *Stereosoma* of Hickson is nearer to *Anthelia* than it is to *Clavularia* in which Schenk and May have it included, and certainly there is more difference between *Anthelia* and *Clavularia* than there is between *Anthelia* and *Stereosoma*. Thus, in this paper *Anthelia* is treated as a genus distinct from *Clavularia*.

In 1916, Kükenthal revised the genus *Anthelia* and gave a more or less clear-cut distinction between it and the genus *Clavularia*. The basis of the separation is the absence or presence of a distinct calyx. In *Anthelia* the polyp body is not divided into an apical thin-walled portion and a basal thick-walled calyx and the polyps are nonretractile. In *Clavularia*, however, the polyp body is so divided and the upper thin-walled portion can be retracted into the calyx. Molander (1918), however, stated that a calyx cannot be said always to be absent in *Anthelia*, as in certain cases it is possible that the upper moiety of the polyp may be retracted resulting in a sort of pseudocalyx. Such a retraction occurs in none of the examples of *Anthelia* that I have examined. The distinction that Molander gave, however, is very useful, and I am quoting his diagnosis of the genus *Anthelia* (1921).

I have examined the original specimens of *Clavularia longissima* of May and *Clavularia inflata* of Schenk, both in the Berlin Museum, and I am convinced that they belong to different genera. *Clavularia longissima* has no calyx and all its sclerites are of the same form and size. As such it must be included in *Anthelia*. *Clavularia inflata* has a distinct calyx into the upper portion of which the distal moiety of the polyp can be retracted, and it has several types of sclerites.

To separate the genus from *Clavularia* very distinctly I give a more or less literal translation of Molander's diagnosis of *Anthelia*, as follows:

Cornulariids whose free polyps are united either by a stolon or a thin membranous plate which contains canals arranged netlike. A horny secretion is absent from the polyps. The polyps which are not retractile are thin-walled and simple, not divided into an upper thin-walled and a lower thick-walled part. The

sclerites may be absent; when present they are small sticks, discs, or dumb-bells, finely granular or weakly warted. The tentacles often carry several rows of pinnules.

With this definition of the genus, the following species definitely belong to it. Those not enumerated here either belong to other genera or are so insufficiently described that ascertaining their exact position is very difficult.

1. ANTHELIA GLAUCA Savigny.
   Anthelia strumosa Ehrenberg (1834).
   Sympodium filiginosum Ehrenberg (1834).
   Sympodium purpurascens Ehrenberg (1834).
   Anthelia fuliginosa Kükenthal (1904).
   Clavularia garciae Hickson (1894).
   Clavularia ternatana Schenk (1896).
   Clavularia strumosa May (1899).
   Clavularia pulchra Thomson and Henderson (1906).
2. ANTHELIA FLAVA (May).
   Clavularia flava May (1899).
   Clavularia strumosa Thomson and Henderson (1906).
   Clavularia crosslandi Thomson and Henderson (1906).
3. ANTHELIA MARGARITIFERA (Thomson and Henderson).
   Clavularia margaritifera Thomson and Henderson (1906).
4. ANTHELIA REPENS (Thomson and Henderson).
   Clavularia repens Thomson and Henderson (1906).
5. ANTHELIA AMBOINENSIS (Burchardt).
   Clavularia amboinensis Burchardt (1902).
6. ANTHELIA MOLLIS (Thomson and Henderson).
   Clavularia mollis Thomson and Henderson (1906).
7. ANTHELIA PREGNANS (Thomson and Henderson).
   Clavularia pregnans Thomson and Henderson (1906).
8. ANTHELIA REPTANS (Hickson).
   Clavularia reptans Hickson (1894).
9. ANTHELIA LONGISSIMA (May).
   Clavularia longissima May (1899).
   Anthelia lineata Stimpson (1856).
10. ANTHELIA JAPONICA Kükenthal (1906).
11. ANTHELIA PARVULA (Thomson and Henderson).
    Clavularia parvula Thomson and Henderson (1906).
12. ANTHELIA CELEBENSIS (Hickson).
    Clavularia celebensis Hickson (1894).
13. ANTHELIA GRACILIS (May).
    Clavularia gracilis May (1899).
14. ANTHELIA ARMATA Thomson (1927).

To these many species of *Anthelia* I here add six that have to be described as new. The material on which these species are based was recently collected from shallow waters of the Philippines and was taken to Europe for comparison with the recognized species of the genus. Types of the new species are de-

posited in the University of the Philippines zoölogical collection, and cotypes are to be found in the zoölogical museum of the University of Berlin. The six new species are *Anthelia boquetei*, *A. palawanense*, *A. molanderi*, *A. philippinense*, *A. elongata*, and *A. rosea*.

Key to the species of Anthelia Savigny.

a [1]. Polyps and colonies with sclerites.
b [1]. Sclerites oval discs.
c [1]. Pinnules in four rows on either side, fingerlike.... *A. flava* (May).
c [2]. Pinnules in three rows on either side, conical.... *A. boquetei* sp. nov.
b [2]. Sclerites elongate to rhombic, thin and flat discs.
c [1]. Polyps very small, polyp body and tentacles together less than 5 mm high .... *A. armata* Thomson.
c [2]. Polyps large, polyp body and tentacles together more than 5 mm high.
d [1]. Pinnules short, stout, conical.
e [1]. Polyps short, stout.................................. *A. palawanense* sp. nov.
e [2]. Polyps slender, more than 10 mm high.... *A. molanderi* sp. nov.
d [2]. Pinnules long, fingerlike or sausagelike.
e [1]. Pinnules coarse, widely separate, less than ten in a row. *A. philippinense* sp. nov.
e [2]. Pinnules fine, closely set, more than ten in a row.
f [1]. Polyp bodies slender and very tall, usually longer than 30 mm.. *A. elongata* sp. nov.
f [2]. Polyps less than 30 mm, not very slender.
g [1]. Polyps medium sized, more than 10 mm high, pinnules usually more than fifteen in a row. *A. glauca* (Lamarck).
g [2]. Polyps small, never more than 10 mm high, pinnules usually less than fifteen in a row........ *A. rosea* sp. nov.
b [3]. Sclerites dumb-bell-shaped sticks or capstans.
c [1]. Sclerites minute capstans, 0.03 to 0.05 mm. *A. repens* (Thomson and Henderson).
c [2]. Sclerites capstanlike double clubs and double wheels, 0.04 to 0.07 mm............................ *A. margaritifera* (Thomson and Henderson).
a [2]. Polyps and colonies without sclerites.
b [1]. Tentacles without pinnules.................... *A. amboinensis* (Burchardt).
b [2]. Tentacles with pinnules.
c [1]. Pinnules all around the tentacles.
d [1]. Pinnules long, slender.............*A. mollis* (Thomson and Henderson).
d [2]. Pinnules short, conical.. *A. pregnans* (Thomson and Henderson).
c [2]. Middle portion of tentacle free from pinnules.
d [1]. Tentacle very short, about 1 mm................ *A. reptans* (Hickson).
d [2]. Tentacle 10 mm or longer............................ *A. longissima* (May).
d [3]. Tentacles 2 and 5 mm long.
e [1]. Pinnules in one row on either side.
f [1]. Pinnules long, about twenty in a row. *A. japonica* (Kükenthal).

f^2. Pinnules cylindrical, nine or ten in a row.
A. parvula (Thomson and Henderson).

e^2. Pinnules in more than one row (two to four) on either side.

f^1. Pinnules long, featherlike, 0.5 mm long.
A. celebensis (Hickson).

f^2. Pinnules short, wartlike, about 0.2 mm long.
A. gracilis (May).

ANTHELIA FLAVA (May).

Clavularia flava MAY, Jena Zeitschr. f. Naturw. 33 (1899) 43, pl. 1, fig. 3.

Pinnules short, stumpy, in four rows on either side, leaving only the distal half of the tentacular inner surface free. Oval sclerites present all over.

From a rather thick wide basal membrane, numerous polyps arise close to each other. Polyps with bodies from 6 to 15 mm long (without tentacles) and 1 to 1.7 mm wide. Tentacle axis narrow, more or less circular in cross section, 5 to 8 mm long and 0.5 to 0.6 mm wide at base. Pinnules closely set, in four close rows on either side of tentacles. From eighteen to twenty-two pinnules in a row. Pinnules stumpy, but not conical, the longest 0.48 mm long and 0.144 mm wide, the majority much shorter, the distal half of tentacular inner surface almost fully covered by them. Sclerites present all over; minute, flat, oval, biscuitlike discs, 0.0209 mm long and 0.0132 mm wide.

Previously recorded from Zanzibar. Type in Hamburg Museum.

Philippine material is described from an extensive colony growing around a piece of dead stag-horn coral obtained at Taytay, Palawan.

This material differs slightly from the type in having the distal half of the tentacle fully covered by the pinnules. This, however, may be due to a difference in the state of contraction.

ANTHELIA BOQUETEI sp. nov.

Polyps very small, with relatively long tentacles. Pinnules mostly conical, in three rows on either side of tentacle. Entire inner surface of tentacle free. Oval sclerites present.

From a very thin spreading basal membrane, numerous polyps arise very close together, sometimes their bases touching each other. Polyps small and delicate-looking with bodies 2 to 5 mm long (exclusive of tentacles) and 0.5 to 0.8 mm wide, marked with eight fine longitudinal lines. Tentacle axis almost cylindrical, from 3 to 5 mm long and 0.4 to 0.5 mm wide near base.

Pinnules short, fat, and conical, in three rows on either side of inner surface of tentacle. Those near base may be only knob-like. There are usually sixteen pinnules in a row. Largest pinnules near middle of tentacle, about 0.24 mm long and 0.088 mm wide at base. Sclerites present all over, with the form of tiny, flat, oval, biscuitlike discs, 0.019 mm long and 0.013 mm wide.

This new species is described from several extensive colonies growing on pieces of corals obtained from Puerto Galera Bay, Mindoro Island, Philippines.

This species comes closest to *Anthelia gracilis* (May). Unlike this, however, *A. boquetei* has polyps growing very close to each other and has sclerites all over the colonies. In *A. gracilis,* the polyps are 1 to 2 mm apart and sclerites are entirely absent.

ANTHELIA PALAWANENSE sp. nov.

Basal membrane very thin, polyps stout, fat, and low, tentacles wide, truncated, and short, pinnules in two rows, also very short, stout, and conical. Sclerites elongate, narrow discs with finely granular surface.

From a very thin flat continuous basal membrane, numerous densely crowded polyps arise. These are very short and stout, about 3 to 5 mm high (tentacles not included) and about 3 mm wide, with very thick body walls. As a result of partial contraction, the body wall may show several transverse lines or grooves. Tentacles stout, short, and fat, about 2.5 to 3 mm long and 1.2 to 1.4 mm wide. They are contractile but never retractile, showing numerous transverse corrugations. The ends are more or less truncated, never pointed. Pinnules rounded, thick-looking, many times stout cones. They are in two irregular rows on lateral sides of tentacles. The longest are about 0.8 mm long, although the majority are 0.5 to 0.6 mm long and 0.3 to 0.4 mm wide. Sclerites present, uniform throughout. They are tiny, thin, elongate discs with truncated ends, 0.04 to 0.055 mm long and 0.014 to 0.015 mm wide, with finely granular surface. They are thickly arranged, giving a matlike appearance.

The type was collected at Taytay, Palawan, by Light and Griffin in 1914 and labelled *Clavularia.* This specimen, however, must be referred to *Anthelia* as the sclerites are the same throughout and no portion of the polyp body that can be called a calyx is present. Polyps, although clearly contractile, are not retractile, either partially or fully.

ANTHELIA MOLANDERI sp. nov.

Polyps medium sized, with thick body wall. Tentacle axis lanceolate. Pinnules short, stout, often conical, in two rows on either side of the tentacle. Sclerites elongate thin discs.

From a rather thick basal membrane numerous medium-sized zooids arise close together with their bases touching each other. Body of polyp, excluding tentacles, 12 to 16 mm high and 2 to 2.5 mm wide; body wall thick and smooth. Tentacles with somewhat flattened, lance-shaped axis gradually tapering towards the tip, 6 to 8 mm long and 0.8 to 0.96 mm wide near base. Pinnules short, stout, mostly conical in two close rows on either side of the free median surface of tentacle. The longest measure 0.6 to 0.8 mm long and 0.12 to 0.17 mm wide, usually only five times as long as wide. There are from fourteen to twenty pinnules in a single row. Sclerites most numerous on body wall and basal plate, less in tentacles and pinnules. They are elongate, thin discs, about 0.035 mm long and 0.0088 mm wide with rounded ends.

This form differs from most of the Philippine species of *Anthelia* in having short, stout, conical pinnules which are very closely set. The polyps are much longer and slenderer than in *A. palawanense.* The tentacles, which in *A. palawanense* are blunt, stout, and short, are here slender and pointed.

Type: No. 3095–C, University of the Philippines zoölogical collection.

ANTHELIA PHILIPPINENSE sp. nov.

Polyps large, with thick body walls, pinnules large, cylindrical, in two rows on either side of tentacle. Sclerites elongate, truncate discs present in all parts.

From a rather thick basal membrane, about 3 to 4 mm in thickness, numerous zooids arise with their bases close together. Polyps tall with thick firm-looking body wall measuring 28 to 35 mm high (without tentacles) and 4 mm in diameter. Tentacles long with a cylindrical axis tapering towards the tip, 10 to 12 mm long and 0.8 mm wide near base. Pinnules coarse looking, widely separated, cylindrical, and fingerlike with rounded tips. They are in two rows on either side of tentacle; apically they may appear as if only in one row. There are eight to ten pinnules in a row. The majority are about 2 mm long and 0.34 mm wide. A few are much shorter, even less than 0.5 mm long. Sclerites are present all over the polyps and the

basal membrane. They are tiny rod-shaped sticks 0.044 mm long and 0.009 mm wide with truncated ends and minutely granular surface. Color of colony in spirit is light yellowish green.

Collected at Puerto Galera, Mindoro.

This differs from other forms of *Anthelia* in having large and widely separated, coarse-looking pinnules, much like those of *Stereosoma celebense* Hickson. Unlike this, however, the colony is contractile, especially the pinnules which may become curled or bent in various ways when touched or badly fixed, and sclerites are present.

ANTHELIA ELONGATA sp. nov.

Pinnules long, cylindrical, in two rows on either side of cylindrical tentacle. Polyps tall and slender, about 45 mm high and 2 mm wide. Sclerites present.

From a thick incrusting, flat, basal membrane about 2 mm thick, numerous zooids arise with their bases almost touching each other. Bodies of zooids long and slender, the longest more than 45 mm high and 1.5 to 3.0 mm wide, excluding tentacles. Body wall somewhat thick but not firm. Tentacles slender with a cylindrical axis 8 to 10 mm long and 0.4 to 0.5 mm wide near base. Pinnules in two close rows on either side of tentacle. Apically the pinnules may appear as if in a single row. They are long and cylindrical with a blunt end, the longest measure 1.5 to 1.8 mm long and 0.16 mm wide. There are from fifteen to twenty-two pinnules in a row. Polyp body as well as tentacles and pinnules sparsely provided with tiny sclerites. These are rod-shaped, slender sticks with blunt ends and with the surface finely granular. They are 0.0518 mm long and 0.0074 mm wide. Color in life deep brown. Very common in Puerto Galera Bay, Mindoro, Philippines.

This form is closest to *Anthelia longissima* (May) in external appearance. May's type, however, did not have any sclerites and he pictures the species as always having an enlarged portion of the polyp body just below the tentacles. This, however, is not constant and it may be due to fixation or preservation. I have seen this species in life, in its natural habitat, and such an expanded portion of the body is not present. When fixed or placed in preservatives, the entire body has a tendency to contract, forcing the contents of the gastral canal upward and downward. For this reason many specimens of *Anthelia* ex-

hibit enlarged body portions either near the base or just beneath the mouth. May describes his material as having only one row of pinnules on either side of the tentacle. In this new species there are two very distinct rows.

ANTHELIA GLAUCA Savigny.

Anthelia glauca SAVIGNY, Des. d. l'Egypt Hist. Natur. Supp. **1** (1817); EHRENBERG, Corallenthiere des roten Meeres (1833) 54; LAMARCK, Hist. Nat. Anim. sans Vertebres **2** (1836) 622; KÜKENTHAL, Alcyon. Tiefsee-Exp. **33** (1906) 11; MOLANDER, Archiv f. Zool. **14** (1921) 6.

Clavularia garciæ HICKSON, Rev. Alcyon. Stol., Trans. Zool. Soc. **13** (1894) 341, pl. 44.

Clavularia ternatana SCHENK, Abhandl. Senckenb. naturf. Gesellsch. **23** (1896).

Clavularia strumosa MAY, Jena Zeitschr. f. Naturw. **33** (1899) 42, pl. 1, fig. 2.

Clavularia pulchra THOMSON and HENDERSON, Proc. Zoöl. Soc. London (1906) 405.

I am referring to this variable specimens of the *Anthelia* most commonly found in Philippine waters. They all agree in having medium-sized colonies whose polyps are united at the base by a basal membrane and with fairly thin body wall, long tentacles with lanceolate axis and with elongate, sausage-shaped, closely set pinnules with pointed ends, usually in two rows. Polyps usually close together. Sclerites are tiny, flat, elongate, truncated discs.

In several colonies, polyps are short with relatively stout bodies, 6 to 12 mm long (tentacles not included), often the swollen basal portions 4 to 5 mm in diameter. Apically, body narrows to about 2 mm in diameter. Tentacle axis slightly flattened and gradually tapering to tip, 4 to 5 mm long and 0.6 to 0.8 mm wide at base. Pinnules in two rows, fingerlike, 1.0 to 1.4 mm long and 0.2 to 0.3 mm wide at base. There are usually thirteen or fourteen pinnules in a row. Sclerites numerous, rodlike sticks with minutely granular surface, 0.042 mm long and 0.0074 to 0.011 mm wide. Light creamy yellow.

In second group of colonies, polyps are as much as 20 mm high and 2 to 5 mm wide (tentacles not included). Tentacles 11 to 14 mm long and 2 to 3 mm wide near base. Pinnules in two rows, 1.5 to 3 mm long and 0.2 to 0.23 mm wide near base. There are sixteen to twenty pinnules in a row. Entire colony beset with numerous sclerites, elongate, tiny, blunt, rodshaped discs with minutely granular surface, 0.057 mm long and 0.0085 mm wide. Creamy white or yellowish green.

In a third group of colonies, body wall thin and transparent probably from long preservation, 10 to 20 mm long and 2 to 3 mm wide. Tentacle axis more or less flattened, about 10 mm long and 0.96 mm wide at base. Pinnules also in two alternating rows, fingerlike, pointed at tip, the longest 1.5 mm long and 0.39 mm wide at base. Sclerites flat, tiny, narrow discs, 0.033 mm long and 0.39 mm wide.

All of the specimens of *Anthelia* sent by Griffin and Light to Kükenthal in 1914, which are also in the Berlin Museum, belong to this species. I have examined the type of Schenk's *Clavularia ternatana* and I believe that it should also be included under this species. I have not seen *C. garciæ* Hickson and *C. pulchra* Thomson and Henderson, but from the description and illustration of the former and the description of the latter, I gathered that they should also be included under *A. glauca,* which is a very variable species, as all workers of the group know.

ANTHELIA ROSEA sp. nov.

Polyps small with bodies never more than 10 mm high, connected by a very thin encrusting basal membrane. Tentacles with cylindrical tapering axis. Pinnules in two close rows. Sclerites elongate, thin, narrow discs.

Polyps small, either closely set, with their bases almost touching each other, or separated by about 1 mm and connected by a thin basal membrane. Polyp bodies usually between 5 and 6 mm high (tentacles excluded) and about 2 mm in diameter. A few may reach a height of 8 mm but never more than 10 mm. Tentacles firm looking, with cylindrical, abruptly tapering axis, 4 to 5 mm long and 0.6 to 0.7 mm wide at base. Pinnules very long in proportion to size of polyps and length of tentacles. They are in two close rows on either side of the free median surfaces of tentacle. There are twelve to fifteen pinnules in a row, the longest 1.1 mm long and 0.24 mm wide at base. Sclerites present all over, in basal membrane, body wall, tentacles, pinnules, and even mesenteries. They are elongate, narrow, thin discs, about 0.033 mm long and 0.007 mm wide.

The type is an extensive colony growing on a piece of sponge. The tentacles when fully expanded are very regularly arranged around the mouth and appear like petals of a flower. It approaches *A. boquetei* in size, but the spiculation and the pinnules are distinctly different.

Type: No. 5013–C, University of the Philippines zoölogical collection. Collected at Puerto Galera.

Family XENIIDÆ Verrill

Xenina EHRENBERG, Abh. Akad. Berlin (1832) 277.
Xeninæ DANA, Zoophytes (1846) 604.
Alcyoninæ MILNE-EDWARDS, Hist. Nat. des Corall. 1 (1857) 113, 125.
Xeniadæ GRAY, Ann. & Mag. Nat. Hist. 14 (1859) 433.
Xeniidæ VERRILL, Proc. Essex Inst. 4 (1866) 148.
Alcyoninæ exsertæ KLUNZINGER, Die Korallthiere des roten Meeres 1 (1877) 39.

The family Xeniidæ, as originally constituted, with the exception of two species, *Xenia antarctica* and *X. wandeli* (Arctic Ocean), is wholly tropical or subtropical in distribution, mostly found in the Indian Ocean, the Red Sea, and the Pacific Ocean. Practically all known members of the Xeniidæ are inhabitants of very shallow waters; except *Xenia antarctica* and *X. wandeli*, none has been collected from deep waters. Recently, however, the genus *Sympodium* with many deep-sea and cold-water species has been included in this family.

In the Philippines, the members of the family are mostly encountered on very shallow reefs located in well-protected bays or in coves unexposed to the prevailing wind. This is beautifully illustrated in the Puerto Galera region, Mindoro. Many members of the group thrive best in the almost land-locked Puerto Galera Bay and in that part of Sabang Cove where the water is quiet and the place unexposed to the strong prevailing northwest wind. They are conspicuously absent in more-exposed regions, such as Varadero Bay and the shores of Maricaban and Verde Islands. They are usually attached to old or new pieces of coral just above the lowest tide level. A few are located at a higher level, so that during low water they are seen as irregular limp masses partially covering the stones to which they are attached. In life they are variously colored, although the majority exhibit light hues of yellow, brown, blue, and lilac. A colony seldom has one general color. Usually the stalk, the polyp bodies, and the tentacles are differently tinged.

Practically all students of this group, including Ashworth, Bourne, Hickson, Kükenthal, Light, May, Schenk, Thomson, and Henderson, complain of the difficulty in working out the family due to the instability of the diagnostic characters used. The writer is cognizant of this difficulty and to obviate errors as much as possible, a uniform method of collection and preservation is used in working out the Philippine forms. The animal and, if possible, the piece of stone to which it is attached, is carefully lifted and placed in a blue pan with a sufficient amount

of sea water. Its color, the general condition of the tentacles and pinnules, such as their shape and extent, are studied. The animal is then transferred to another pan and anæsthetized by the use of a gradually dissolving bag of magnesium sulphate. When it is fully expanded and shows no sign of capacity to contract, it is transferred to a 10 per cent solution of formalin in sea water.

Detailed study of the specimen, such as counting the rows of pinnules and the number in a row and measuring the various parts, is made in the laboratory. By this uniform method, error arising from the difference in the state of contraction of the tentacles and pinnules is eliminated to a great extent. Measurements of very small parts, as the length and breadth of the tentacles, the length and diameter of pinnules, and dimensions of spicules, are made with an ocular micrometer. When the pinnules are long and very closely set, counting rows and the number in a row is difficult. In such a case, the tentacle is split longitudinally along the mid-external and internal lines and the counts are made from the inside.

Xeniidæ are Alcyonacea with polyps united basally through a mass of cœnenchyme which is traversed by an extensive endodermal canal system. The united portions of the polyps form a fleshy, soft base or stalk, usually columnar, sometimes branching or spreading, from which the nonretractile free portions of the polyps extend. Often the apical portion of this stalk forms an expanded disc or capitulum, as in *Xenia* and *Heteroxenia*, which forms a sort of boundary between the exposed sexual portion and the basal, concealed, nonsexual portion of the polyps. The polyps are usually numerous, well spaced or closely set, on the upper portion of the stalk. Often they are so thickly crowded that very little, if any, of the upper surface of the capitulum is visible.

In *Cespitularia* the stalk is much branched and no definite capitulum can be said to exist. The polyps are either monomorphic (*Xenia, Cespitularia,* and *Sympodium*) or dimorphic (*Heteroxenia*). The free portion of the polyps may arise from about the same level on the capitulum (*Xenia* and *Heteroxenia*), at different levels of the stalk (*Cespitularia*), or from a basal stolon (*Sympodium*). The surface of the stalk when present is usually smooth, but at times it may be traversed by fine or large and shallow longitudinal grooves. The periphery of the capitulum is often marked by very fine, short, vertical ridges.

Many species, upon handling, secrete a thick or thin mucous substance, the nature, origin, and use of which are unknown.

As additional characteristics of the group may be added the presence of digestive goblet cells in the stomodeum which are ectodermal in origin and the absence of the six ventral and lateral mesenterial filaments. Only the two dorsal filaments are present. The single ventral groove of the stomodeum, the siphonoglyph, is provided with cilia only on its basal third. The retractor muscles, which are well developed in most alcyonarians, are either wanting or very poorly developed in the group.

The spicules of the group are characteristic. They are more or less uniform in structure and size in all the species, and serve, more than any other structure, to bind the different members together into a distinct group. The spicules are mostly located on the external surface of the polyps in the mesoglœa just beneath the ectoderm. These are minute and thin discs usually oval or elliptical, sometimes more or less oblong with a slight, hardly visible constriction at the sides. On the average they have a long diameter of 0.02 mm and a short diameter of 0.012 mm. In transmitted light they appear yellowish, but in reflected light they appear whitish. They readily stain with any kind of hæmatoxylin stain. According to Bourne (1895) this is due to the fact that they are "somewhat feebly calcareous, and contain an abundant organic basis." In both the autozooids and siphonozooids they are usually least abundant towards the base of the zooids. They come in greater numbers apically where they are crowded on the external surface of the tentacles. In the case of autozooids they are usually numerous and crowded together on the pinnules when present.

Of great taxonomic value is the character of the tentacles and pinnules. The tentacle axis is either flattened or columnar, tapering to a point, either tongue-shaped, lanceolate, or nearly of uniform width for the greatest extent. The tentacle is always provided with pinnules, usually situated on its internal surface, but at times also on its external surface. These pinnules, which vary in shape from rounded or pointed wartlike cones to much elongate, filiform ones, are in two series of one to five regular or irregular rows on either side of the inner median line of tentacles. In some forms the series are far apart and leave a wide bare space of the tentacle between them. In others, however, the two series approach each other very closely so that only a very narrow space, if any, is left between

them. In the latter case, the tentacle or its part is said to be not "free."

On the basis of the length and shape of pinnules, Schenk (1896) divided the genus *Xenia* into three subgenera; namely, those with long pinnules throughout the whole length of the tentacles, those with short pinnules basally and long apically, and those with short pinnules throughout. It must be said, however, that whether the pinnules are long or short, those at or towards the base are always much smaller than those towards the middle, and usually many intermediate forms come between the three subgenera of Schenk. Even in the forms having the majority of pinnules much elongate, filiform, and pointed, those at or towards the base may be in the form of short, rounded warts.

In this paper, the family is treated as having four distinct genera; namely, *Heteroxenia, Xenia, Cespitularia,* and *Sympodium.* The last three are universally accepted as valid genera. Opinions vary with regard to *Heteroxenia,* and a long and picturesque controversy over its validity has been going on in the last century and a half.

Kölliker in 1874 described *Heteroxenia elizabethæ* and found many small individuals in addition to the ordinary large ones. He considered that among the small forms two kinds exist; some are young polyps in various stages of development, but the majority are zooids. According to him there is a distinct dimorphism in the genus *Heteroxenia,* the polyps are large and sexual with prominent tentacles and pinnules, and with a cœlenteron extending far into the stem, while the zooids are more numerous, small, and never grow beyond a certain maximum size; they are nonsexual, with abbreviated tentacles not provided with pinnules, and with a cœlenteron not extending far into the stem.

Klunzinger, working on the Xeniidæ of the Red Sea, saw very many polyps in one member of the family. He noted that small individuals never develop into fully formed polyps, but "remain in the bud-like stage, with short, simple, mostly incurled tentacles." Instead of describing this species under *Heteroxenia,* he called it *Xenia fuscescens* and placed it near *Heteroxenia elizabethæ* of Kölliker.

Haacke (1886), working on the Xeniidæ of Torres Strait, said that the small and apparently rudimentary forms are nothing but young polyp buds and that he found all stages be-

tween them and the adult polyps. It is certain that Haacke was right in his observation, but whether he was working with a form of *Xenia* or *Heteroxenia* is still a question.

Wright and Studer (1889), in the Challenger Report, briefly noted these statements of Klunzinger and Haacke and proposed the temporary abandonment of the genus.

Bourne (1895), working on *Xenia umbellata* var. *coerulea* and *Xenia garciae* from Diego Garcia Island (Indian Ocean) and on a colony of *Heteroxenia* from Zanzibar, stated that Kölliker's genus is valid and that Haacke's "criticisms must have been founded on a study of members of the genus *Xenia*, which are abundant in the Torres Strait and Great Barrier Reef of Australia." To him there is no doubt that in *Heteroxenia* a distinct dimorphism occurs.

Schenk (1896), who described several new forms of *Xenia* from Ternate, remarked that he believes the zooids of Kölliker are merely young polyps and supported Haacke's view that no dimorphism exists in the Xeniidæ. In fact, he transferred *Heteroxenia elizabethæ* to *Xenia*. Schenk's example was followed by May (1899).

Hickson (1902), working on the alcyonarians of Cape of Good Hope and recognizing the results of Kölliker, Bourne, and Ashworth, founded a new species which he called *Heteroxenia capensis*.

Following the example of Ashworth (1899), I studied autozooids of various sizes of a form I am calling *Heteroxenia mindorensis*. Table 1 shows that as the polyp increases in length, there is a corresponding increase in the length of the tentacles and in the number of pinnules. A similar study, however, of the siphonozooids, Table 2, shows no corresponding increase in the length of the tentacles as the zooids increase in length. In none of the siphonozooids have pinnules been found, although many or all of them are longer and larger than the youngest autozooids.

Histological studies on the two kinds of zooids of *Heteroxenia mindorensis* confirm Ashworth's observation that in both siphonoglyph with cilia toward the basal part is present. The cœlenteron of the autozooid extends down into the base of the syndete and always has a slightly expanded end. That of the siphonozooid, however, never extends for more than 2 mm into the syndete and has always a pointed end uniting with the superficial

canal system. That the autozooids are sexual and the siphonozooids are not is beautifully illustrated in the serial sections of my specimen.

The two dorsal mesenterial filaments in the siphonozooids, unlike those in the autozooids, are very inconspicuous and short, and extend only for a very short distance below the stomodeum. In the autozooids these two dorsal mesenteries are very highly developed, more or less convoluted, and they extend up to the base of the cœlenteron. The mesenteries themselves are very thin in the siphonozooids, not more than 0.01 mm thick, against the usual 0.05 mm mesenterial thickness in the autozooid. As first pointed out by Ashworth (1899) no trace of retractor muscles is found in the mesenteries of the siphonozooids. These muscles are very prominent in all mesenteries of autozooids that I have examined.

After the examination of all the material on hand, I am of the belief that the difficulty in visualizing the validity of this genus lies in the fact that heretofore only one species of the genus, *Heteroxenia elizabethæ*, has been extensively studied and described. In this paper I am describing seven forms besides *Heteroxenia elizabethæ*, all of which show a distinct dimorphism. I am certain that none of these is identical with *H. capensis*, *H. rigida* May, or *H. uniserta*, the only species except *H. elizabethæ* (*X. ashworthi* of Kükenthal) known to possess dimorphism. It is to be regretted that in spite of the recent splendid work of Hickson on the Xeniidæ (1930), Thomson and Dean (1931) did not adopt the genus *Heteroxenia;* they referred *H. capensis* and *H. elizabethæ* to *Xenia* as *X. capensis* and *X. ashworthi*, respectively.

The siphonozooids of all of the species of *Heteroxenia* described here are more or less alike despite obvious dissimilarities of the autozooids. If these small siphonozooids are nothing but young developing polyps, they should at least show more diversity in size, because it is quite unnatural that so many developing young polyps of the same size should be found at one time when the older polyps themselves are of various sizes. Light (1915), discussing the same point, said, "The number of siphonozooids is so great in proportion to the number of autozooids, their size is so uniform and so much less than that of the autozooids, and these conditions have been noted by so many independent workers from specimens from so many widely separated habitats that it seems hardly conceivable that we have here merely growing polyps."

In life, full-grown examples of *Heteroxenia* can be told from *Xenia* by the much crowded arrangements of the two kinds of zooids, leaving no portion of the external surface of the capitulum exposed. It appears in practically all species of *Heteroxenia* I have examined that the autozooids develop in the colony much earlier than the siphonozooids. This is borne out by the fact that in places where most of the young developing autozooids are located, as along the outer margin of the disc, very few or no siphonozooids are to be found. It is in the center of the colony, where adult autozooids are mostly located, that numerous siphonozooids are also found. Furthermore, in very small colonies of *Heteroxenia*, the siphonozooids are entirely wanting, appearing only after the colony has attained a certain size. This is shown in the following table of different colonies of *Heteroxenia philippinensis:*

Colony No.—	Basal diameter.	Diameter of terminal disc (capitulum).	Siphonozooids.
	mm.	*mm.*	
1	5	8	Entirely absent.
2	6	11	Do.
3	7	15	Do.
4	9	20	At center of disc only, none towards periphery.
5	12	19	At center of disc only, one towards periphery.
6	15	26	Present all over.
7	16	29	Do.
8	20	32	Do.

The youngest autozooids can be distinguished from the siphonozooids as they are very solid-looking from the very beginning and more or less rounded, about 1 mm or less in length and 0.4 mm in diameter. Very soon the apical end flattens and begins to divide into eight knobs which represent the rudiments of the tentacles. These knobs, which are already present in polyps 1.5 mm long, are 0.2 to 0.3 mm long and 0.16 mm wide at first. The tentacles when just growing out increase in length much faster than the polyp body, and those that are 0.6 to 0.7 mm long have already two or three small wartlike pinnules on their sides. The tentacles may not grow at the same rate, sometimes two or three growing much faster than the others. In the same young polyp, some tentacles may already have seven or eight pinnules, although some may still show none. Despite the difference as to time and space in the development of the two kinds of zooids in *Heteroxenia*, there is no indication of

intermediate forms existing between monomorphic and dimorphic xeniids, and I can confirm Hickson's statement that "dimorphism is an established physiological condition" in *Heteroxenia*. I have examined very numerous living xeniids and I am convinced that "a Xeniid is either dimorphic or it is not." (Hickson, 1931, p. 142.)

TABLE 1.—*Measurements of the autozooids of Heteroxenia mindorensis.*

Autozooid.	Length of polyp, including tentacles.	Width of polyp.	Length of tentacles.	Pinnules in outermost row.
	mm.	*mm.*	*mm.*	
A_1	20.0	1.0	7.0	21–23
A_2	17.0	2.2	8.0	20–21
A_3	13.0	0.9	6.8	20–21
A_4	11.0	0.8	6.0	19–21
A_5	8.0	0.7	5.0	15–17
A_6	5.4	0.6	3.5	13
A_7	4.0	0.5	2.2	11–12
A_8	3.0	0.8	1.4	7–8
A_9	2.5	0.8	0.9	4–7
A_{10}	1.8	0.7	0.6	2–3
A_{11}	1.5	0.5	0.2	None.
A_{12}	0.8	0.4	None.	None.

TABLE 2.—*Measurements of siphonozooids of Heteroxenia mindorensis.*

Siphonozooid.	Length of zooid.	Width of zooid.	Length of tentacles.
	mm.	*mm.*	*mm.*
S_1	3.8	1.3	0.32
S_2	3.7	1.4	0.48
S_3	3.6	1.2	0.42
S_4	3.2	1.2	0.3
S_5	3.0	1.1	0.34
S_6	3.0	0.96	0.38
S_7	2.9	0.98	0.32
S_8	2.8	0.96	0.34
S_9	2.4	0.8	0.45
S_{10}	2.4	0.96	0.35
S_{11}	2.3	0.9	0.32
S_{12}	2.0	0.8	0.3

Genus XENIA Lamarck

Xenia LAMARCK, Hist nat. an. s. Vert. 2 (1816) 409; SAVIGNY, Descr. de l'Egypte, Hist. nat. Suppl. 1 (1817) 227; tab. 1, figs. 3–I to 3–VIII; SCHWEIGGER, Beob. naturh. Reisen (1819) 94; EHRENBERG, Abh. Akad. Berlin, ann. 1833 (1834) 277; KLUNZINGER, Korallthiere des roten Meeres, Theil 1 (1877) 39; SCHENK, Abh. Senckenb. naturf. Ges. Frankfurt 23 (1896) 54; MAY, Jena Zeitschr.

f. Naturw. 33 (1899) 80; ASHWORTH, Willey Zoöl. Results, pt. 4 (1900) 522; KÜKENTHAL, Rev. Alcyon. Zoöl. Jahrb. Syst. 15 (1902) 635–662; HICKSON, Great Barrier Reef Exp., 1928–29 No. 5 4 (1931) 148.

To give the history of this genus is more or less superfluous in the light of the recent works of Kükenthal (1902) and Hickson (1931). It is probably sufficient to summarize the findings of Hickson for the benefit of those who have no access to his paper (1931). There have been no less than thirty-two animals described as belonging to the genus since Lamarck described the first species, *Xenia umbellata.* Hickson reduced these to thirteen valid species, and six species of uncertain status due to insufficient descriptions. The following species, together with their synonymy, are considered valid by Hickson:

1. XENIA UMBELLATA Ehrenberg.
   Xenia fuscescens Ehrenberg.
   Xenia coerulea Ehrenberg.
   Xenia bauiana May.
   Xenia sansibariana May.
   Xenia tumbuatana May.
   Xenia quinquicerta May.
   Xenia medusoides May.
2. XENIA ELONGATA Dana.
3. XENIA HICKSONI Ashworth.
4. XENIA PLICATA Schenk.
   Xenia blumi Schenk.
   Xenia rubens Schenk.
5. XENIA CRASSA Schenk.
   Xenia fusca Schenk.
   Xenia viridis Schenk.
   Xenia membranacea Schenk.
6. XENIA MULTISPICULATA Kükenthal.
7. XENIA NOVAE-BRITANNIAE Ashworth.
8. XENIA TERNATANA Schenk.
9. XENIA NANA Hickson.
10. XENIA CROSSLANDI Kükenthal.
    Xenia rigida Thomson and Henderson.
11. XENIA GARCIAE Bourne.
12. XENIA ANTARCTICA Kükenthal.
13. XENIA WANDELI Jungersen.

The following, due to insufficient descriptions, were considered by him as doubtful species: *Xenia florida* (Lesson), *X. danæ* (Verrill), *X. samoensis* (Studer), *X. ochracea, X. brunnea,* and *X. pulsitans* (Saville Kent).

In this paper *X. danæ* is considered a valid species, and *X. sansibariana, X. blumi, X. viridis,* and *X. membranacea* are treated as distinct species contrary to the above given synonymy.

Of the species enumerated above, eight have been identified as being present in the Philippines. It is worth mentioning that the eight old species, whose Philippine records are herein first given, have been reported also from either Polynesia or the Sunda Islands, furnishing support to the idea that the shallow-reef fauna of the Philippines is much the same as in these two places. Light (1914) also calls attention to the "striking similarity between the general littoral alcyonarian fauna of the Philippines and a region so distant as Zanzibar." The fact that four species of *Xenia* found in the Philippines are also found in Zanzibar may possibly lend specific support to the idea.

Although I am in full sympathy with the serious effort of Hickson to reduce the number of species of this genus as much as possible, I cannot avoid adding to the long list of species. All these new forms were described from living or freshly killed material or from both, and the material described as new could not be found to possess sufficient characters to be described as belonging to the already standing species. The following is a short diagnosis of *Xenia* and a synoptic key to the species reported in this paper:

Xenia, family Xeniidæ, without polyp dimorphism, only autozooids present, all arising at the same level from the terminal expanded portion of the stalk.

Key to the Philippine species of Xenia Lamarck.

a^1. Pinnules on internal surface of tentacles.
  b^1. Pinnules in two rows on either side of the inner surface of tentacle.
    c^1. Pinnules in form of low, rounded warts, eight in a row. *X. kükenthali* sp. nov.
    c^2. Pinnules elongate, cylindrical.
      d^1. Pinnules thick, stout, well spaced, ten to twelve in a row. *X. lilliex* sp. nov.
      d^2. Pinnules slender, much pointed, fifteen to eighteen in a row. *X. puerto-galeræ* sp. nov.
  b^2. Pinnules in three rows on either side of inner surface of tentacles.
    c^1. Pinnules in the form of very short, small, pointed or rounded cones throughout.
      d^1. Tentacles free throughout, pinnules pointed, twenty-three to twenty-five in a row........ *X. danæ* Verrill.
      d^2. Tentacles not free throughout, pinnules rounded, seventeen to nineteen in a row........ *X. intermedia* sp. nov.
    c^2. Pinnules in the form of rounded warts below, longer and cylindrical above.
      d^1. Pinnules eighteen to twenty in a row........ *X. blumi* Schenk.
      d^2. Pinnules fifteen to sixteen in a row........ *X. viridis* Schenk.
    c^3. Pinnules more or less elongate throughout.

d^1. Tentacles not free throughout.
e^1. Tentacle broad, lanceolate .... *X. crassa* Schenk.
e^2. Tentacle narrow, slender .... *X. hicksoni* Ashworth.
d^2. Tentacles free throughout.
e^1. Tentacle axis cylindrical .... *X. cylindrica* sp. nov.
e^2. Tentacle axis flattened.
f^1. Tentacles short, pinnules stout, short ..... *X. elongata* Dana.
f^2. Tentacles long and wide, pinnules long.
X. fisheri sp. nov.
f^3. Tentacles long but narrow, pinnules very long and slender.
X. umbellata Lamarck.
b^3. Pinnules in four rows of pinnules on either side of inner surface.
c^1. Pinnules in the form of short, stout, much pointed cones.
d^1. Polyps large, tentacles wide .... *X. flava* sp. nov.
d^2. Polyps large, tentacles narrow, fingerlike.... *X. delicata* sp. nov.
c^2. Pinnules elongate, more or less filiform.
d^1. Tentacle not free throughout its length, tentacles short and wide, pinnules low, rounded .... *X. membranacea* Schenk.
d^2. Tentacle free throughout its length.
e^1. Polyps large, tentacles long and broad, pinnules very long, rounded at tip .... *X. felicianoi* sp. nov.
e^2. Polyps small, tentacles short, pinnules slender and shorter, pointed at tip .... *X. amparoi* sp. nov.
e^3. Polyps very tall and slender, tentacles short and narrow, pinnules short, stout and rounded at tip.... *X. schenki* sp. nov.
b^4. Pinnules in five rows on either side of inner surface of tentacle.
c^1. Spicules absent, color brown .... *X. sansibariana* May.
c^2. Spicules present, color bluish gray .... *X. mayi* sp. nov.
a^2. Pinnules on both surface of tentacle, one row internally, and two rows externally .... *X. tripartita* sp. nov.

XENIA KÜKENTHALI sp. nov. Plate 1, fig. 1.

Stem much branched, pinnules low, rounded warts in two rows on either side of the tentacle; eight pinnules in a row; spicules absent.

Colony consists of five to six stems arising from a common low base. Stem cylindrical and smooth, varying from 20 to 30 mm long and 8 to 10 mm wide. Apically they divide into two or more branches. The tops of these are enlarged from which the free portions of the polyps arise.

Polyps rather short and stout with bodies 5 to 6 mm long and 3 to 3.5 mm wide, thick looking and not transparent. Tentacles short, stout and rounded at end, 4 to 4.5 mm long and 1.1 mm wide. On either side they are provided with two rows of low, wide, wartlike pinnules, which in some instances can hardly be recognized. Largest ones 0.32 mm high and 0.48 mm wide at base. Outer rows of pinnules situated more to-

ward the external than the internal surface of tentacle. There are usually eight pinnules in a row. Spicules absent. General color pale yellow.

Type: No. 3009–C; 3 colonies, University of the Philippines zoölogical collection.

Locality: Sabang, Puerto Galera, Mindoro.

This differs from *X. lilliеæ* in the presence of low, flat, and wide wartlike pinnules, which are much fewer in number. Although its mode of branching and color are similar to those of *X. florida*, the character and number of pinnules easily separate it from the latter as from any other species of *Xenia*. Its uniform, very low, and wide pinnules are distinct from those of *X. ternatana*.

XENIA LILLIEÆ sp. nov. Plate 1, fig. 2.

Colonies with much-branched stem and with well-spaced, stout, cylindrical, thick but pointed pinnules in two rows on either side of the tentacles, ten to twelve in a row.

Stem much branched, bases of different colonies sometimes connected by a long, narrow, cylindrical stolon. Usually basal stem very short, dividing immediately into several branches. Secondary branches in turn divide into two or three terminal branches with a knob-shaped smooth apical surface from which the widely separate free portions of polyps arise. Polyps from 2 to 4 mm apart. Polyp bodies usually from 5 to 12 mm long and 1.8 to 2.5 mm wide. Tentacles 6 to 8 mm long and 1.1 mm wide. Pinnules very stout, cylindrical and nearly pointed, too large for size of tentacles, not very sharply marked off from tentacle axis and well spaced. Two rows on either side of tentacles present, those in a row more or less uniform in size throughout. Ten to twelve pinnules in a row, those on external row being slightly larger than internal; they average 0.64 to 0.72 mm long and 0.4 mm wide.

Spicules numerous, in form of oval or irregular flat and thin discs, 0.023 mm long and 0.014 mm wide or smaller. General color in life is a beautiful lilac, sometimes various tinges of pink.

Type: No. 3003–C, many colonies, University of the Philippines zoölogical collection.

Locality: Sabang, Puerto Galera, Mindoro.

This species differs from *X. florida* in having longer and narrower tentacles and longer and well-spaced pinnules. The other species described as having two rows of small pinnules

is *X. ternatana.* In this, however, the stem is unbranched and the pinnules are in the form of warts below becoming slender and pointed. Creeping, slender, and cylindrical stolon when present is very characteristic.

XENIA PUERTO-GALERÆ sp. nov. Plate 1, fig. 3.

Colony branching, polyps tall, tentacle thick, proportionately small, with two rows of slender pointed pinnules, fifteen to seventeen in a row.

Three or more smooth stems arise from a common base 20 mm high and 8 mm in diameter. Stems about 20 mm high and 8 mm wide divide into two terminal branches which have a more or less rounded apical disc from which the polyps arise. Polyps few, usually less than fifty polyps at end of a branch. Polyps rather tall, stout and rigid, with very thick bodies about 10 to 15 mm high and 3 mm in diameter. Tentacles short and small in proportion to size of body, with a cylindrical axis 6 to 8 mm long and 0.9 to 1.0 mm in basal diameter. Pinnules in two rows not closely set on either side of tentacles, whose inner median surface is entirely free. Pinnules fifteen to seventeen in a row, slender, pointed cones, usually 0.7 to 0.8 mm high and 0.2 to 0.29 mm wide. When contracted they may appear as short, stout cones about 0.48 mm long. A few towards base of tentacles rounded and much smaller.

Spicules present but not very numerous, in form of thin, oval discs 0.018 mm long and 0.0108 to 0.0124 mm wide. Color in life light or deep brown.

Type: No. 3015–C, University of the Philippines zoölogical collection.

Locality: Muelle and Second Plateau, Puerto Galera, Mindoro.

This species differs from *X. lilliex* in having a greater number of pinnules, which are slenderer. The consistent color of *X. lilliex*, which is various shades of lilac or violet, is never seen in this species.

XENIA DANAE Verrill. Plate 1, fig. 4.

Xenia florida DANA, Zoophytes (1846) 606.
Xenia danae VERRILL, Am. Journn. Sci. **49** (1869) 283.

Colony small, branching, with small polyps. Base usually 20 mm high with a basal diameter of 10 mm or less. This divides into two or more short branches from upper portion of which polyps arise. Body of polyps 3 to 4 mm long and 1 mm in diameter. Tentacles longer than body, more or less cylindrical

and gradually tapering to apex, 5 to 5.5 mm long and 0.4 to 0.48 mm wide at base. Pinnules very tiny, pointed cones in three rows on either side of median inner surface of tentacles which is free throughout its length. Pinnules twenty-two to twenty-five in a row, usually from 0.2 to 0.26 mm long and 0.06 to 0.064 mm wide. Those near base of tentacles mere tiny knobs.

Spicules are numerous, especially under the external surface of tentacles and pinnules.

Stalk and external surface of tentacles light bluish green, while the pinnules are rust brown.

No. 3030–C, University of the Philippines zoölogical collection, from Muelle, Puerto Galera Bay, Mindoro.

The materials here described are probably young colonies, but the branching stem, the shape and the number of small pinnules in three rows, as well as the color appear to agree with the forms described by Verrill from the Fiji Islands.

XENIA INTERMEDIA sp. nov. Plate 1, fig. 5.

Stalk wide, undivided, laterally flattened, polyps medium sized, tentacles narrow, not entirely free, pinnules in form of rounded papillæ basally, longer above, in three or four rows, seventeen to nineteen pinnules in a row.

Stem of colony undivided, with a free base 40 mm high, more or less flattened, with a long diameter of 25 mm and a short diameter of 15 mm. In one colony two fleshy, much-flattened stems arise from a common base. Each is about 30 mm high, 25 mm wide, and 10 mm thick. Polyps on center of expanded disc larger than those at edge. Polyps slender, with bodies 13 to 14 mm long and 1 mm wide. Tentacles narrow, 4 to 5.5 mm long, 0.6 to 0.7 mm wide. Pinnules more or less irregularly arranged. Those at base in form of rounded papillæ in three rows. Apically they become longer and arranged in four distinct rows. Here they measure 0.24 mm high and 0.16 mm wide. Bare median portion of inner surface of tentacle widest at base, where two series of pinnules are 0.4 to 0.5 mm apart. Within a millimeter from tip of tentacles, two series of pinnules come together leaving no bare portion of tentacle. On outer aspect seventeen to nineteen pinnules in a row.

Spicules present, mostly on ectoderm of tentacles and pinnules, in form of tiny biscuits, 0.018 mm long and 0.01 mm wide. Color light flesh pink or grayish pink.

Type: No. 3029–C, University of the Philippines zoölogical collection.

Locality: Medio Island, Puerto Galera Bay, Mindoro.

This species resembles *X. viridis* of Schenk in having rounded warty papillæ basally and longer pinnules above. Unlike it, however, there are four rows of papillæ apically.

XENIA BLUMI Schenk. Plate 1, fig. 7.

Xenia blumi SCHENK, Abh. Senckenb. naturf. Ges. Frankfurt 23 (1896) 65.

Xenia blumi MAY, Jena Zeitschr. f. Naturw. 33 (1899) 81.

Xenia blumi var. *pelsarti* THORPE, Journ. Linn. Soc. 36 (1928) 489.

I am referring to this species several massive colonies which are often very large. In a medium-sized one, the stem is 50 mm high and 30 mm wide. The umbellate disc is much rounded, with a circular outline, about 70 mm in diameter. The polyps are very closely set, forming a mushroomlike moiety. Average-sized polyps have bodies about 10 to 13 mm long and 1.6 to 2.7 mm wide. The largest polyps are as much as 25 mm long (including tentacles) and 1.6 mm wide. The tentacles are relatively short, lanceolate, 5 to 6 mm long and 0.7 to 0.8 mm wide (at base). The pinnules are in three very regular rows on either side of the inner side of the tentacles, leaving a bare median region. There are about eighteen to twenty pinnules in a row. Those situated basally are short, more or less rounded, 0.2 to 0.3 mm long and 0.16 mm wide. Those above are longer, stouter, elongate cones, about 0.5 to 0.6 mm long and 0.2 to 0.3 mm wide.

The stem is fleshlike in color. The body of polyps is very transparent and is of the same color. The tentacles are light blue and the pinnules gray.

Nos. 3044–C and 3002–C, University of the Philippines zoölogical collection, from Puerto Galera Bay, Mindoro.

This species has previously been reported from Ternate (Pacific Ocean), Tonga, East Africa (Indian Ocean), Suez (Red Sea), and Western Australia. Most of our specimens have polyp bodies longer and wider than those described by Schenk from Ternate, although all other measurements are identical. *Xenia blumi* var. *pelsarti* Thorpe should be included in this typical genus. According to Hickson (1921), this form should be merged with *X. plicata* Schenk.

XENIA VIRIDIS Schenk. Plate 1, fig. 6.

Xenia viridis SCHENK, Abh. Senckenb. naturf. Ges. Frankfurt 23 (1896) 62, tab. 2, fig. 4–8.
Xenia viridis ASHWORTH, Willey Zoöl. Results, pt. 4 (1900) 516.

To this species I refer several medium-sized colonies. Stalk undivided, cylindrical, smooth, 30 mm high and 20 mm basal diameter, slightly concave on one side. Disc strongly convex, about 30 mm in longest diameter. Polyps much crowded, medium sized, with bodies 7 to 9 mm long and 1 mm wide. Tentacles about 5 to 6 mm long and 0.6 to 0.8 mm wide. Tentacles free throughout length. Pinnules in three irregular rows on either side of bare medium space of inner surface of tentacles, fourteen to sixteen in a row. Below, they are small and rounded, about 0.32 mm long and 0.16 mm wide or smaller. Those towards the tip are longer, cylindrical with rounded ends, 0.56 mm long and 0.24 mm wide. At places four rows of pinnules may be seen.

Spicules very numerous.

In formalin, stalk is light cream, polyps bluish, pinnules light brown.

No. 3088–C, University of the Philippines zoölogical collection, from Sabang, near Puerto Galera, Mindoro.

This species has been reported from Ternate and New Caledonia. Hickson (1931) believes that it should be merged with the following species.

XENIA CRASSA Schenk. Plate 1, fig. 8.

Xenia crassa SCHENK, Abh. Senckenb. naturf. Ges. Frankfurt 23 (1896) 58, pl. 3, fig. 13.
Xenia crassa ASHWORTH, Willey Zoöl. Results, pt. 4 (1900) 510.

To this species I refer medium-sized colonies with cylindrical stalk, undivided, 28 mm high and 13 mm wide, grooved on either side. Polyps thickly set, medium-sized, with bodies 5 to 6 mm high and 1.5 to 2 mm wide. Tentacles short and wide, about 5 mm long and 0.64 mm wide at base. Pinnules elongate cones, more or less pointed, 0.48 mm long and 0.14 to 0.16 mm wide, densely packed on either side of inner surface of tentacle in two series of three rows each. Two series are together above, but separated below leaving a median bare space. Pinnules sixteen to twenty in a row.

Spicules extraordinarily numerous everywhere under ectoderm, oval or rounded flat discs, 0.0216 to 0.0252 mm long and 0.0108 to 0.0144 mm wide.

Stalk fleshy, capitulum bluish, polyps of same color, pinnules light brown.

Nos. 3071–C and 3011–C, University of the Philippines zoölogical collection, from Sabang, near Puerto Galera, Mindoro.

XENIA HICKSONI Ashworth.

Xenia hicksoni ASHWORTH, Qr. Journ. Mic. Sci. 42 (1899) 248.
Xenia hicksoni KÜKENTHAL, Zoöl. Jahrb. 15 (1902) 648.

Stalk single, cylindrical, tall with small flat base. Stalk about 30 mm high and 10 mm wide, marked with very fine longitudinal ridges. Disc strongly convex on which free portions of polyps are thickly set. Polyps slender but small. Body 6 to 10 mm long and 1 to 1.5 mm wide. Tentacles slender, gradually tapering to a point apically, small in proportion to length of body, 4.5 to 5 mm long and 0.56 to 0.67 mm wide.

Pinnules in two series of three rows each on either side of inner surface of tentacles. Two series separated basally, but about a millimeter from tip they come together leaving no bare median tentacular portion. Pinnules slender, elongate cones, nearly pointed at end. Sixteen to eighteen in a row. Those near middle of tentacle largest, 0.39 to 0.45 mm long and 0.13 mm wide at base. Those toward base of tentacles shorter.

Spicules numerous on body, tentacles, and pinnules, mostly rounded or irregular, tiny, flat, thin discs, 0.0144 to 0.018 mm long and 0.0108 mm wide. Stalk and polyps yellowish cream, pinnules very light brown.

No. 3098–C, University of the Philippines zoölogical collection, from Sabang, near Puerto Galera, Mindoro.

This specimen resembles typical *X. hicksoni* in the size and shape of the tentacles and in the size, shape, and number of pinnules, but the stem is undivided and spicules are present on the tentacles and pinnules, two conditions not found in the type as described by Ashworth.

XENIA CYLINDRICA sp. nov. Plate 1, fig. 9.

Stalk cylindrical, polyps tall, tentacle axis cylindrical, pinnules stout, cylindroid in three closely set rows, eighteen to twenty in a row.

Two cylindrical stalks, 30 to 35 mm high and 20 to 25 mm in basal diameter, bound together basally. Apical end greatly expanded, with a diameter of 35 mm, marked by numerous short ridges. Disc flattened or slightly convex. Polyps not closely set, oldest towards center, youngest along edge of capitulum.

Adult polyps have bodies ranging from 14 to 20 mm in length and 2 to 4 mm in diameter. Axis of tentacles, unlike those of most species of *Xenia*, cylindrical, solid-looking, 7 to 8 mm long, 0.45 mm wide at base, and 0.56 mm at middle. Pinnules elongate, cylindrical and stout, rounded at tip, solid. A number at base short rounded stumps. Largest pinnules just above middle of tentacles, ranging from 0.64 to 0.8 mm long and 0.2 to 0.24 mm wide, in three closely set rows, eighteen to twenty in a row. Sometimes one, two, or three short pinnules are found on external surface of tentacles.

Spicules densely packed under ectoderm in all parts, oval, flat, thick discs with a number of fine circular concentric lines, 0.018 mm long and 0.0126 mm wide.

Stalk and body fleshy or white. Tentacles and pinnules grayish blue.

Type: No. 3076–C, University of the Philippines zoölogical collection.

Locality: Medio Island, near Puerto Galera, Mindoro.

This species, like *X. tumbuatana* May, has cylindrical tentacle axis. It differs, however, from the latter in having larger polyps and numerous spicules. It differs from *X. schenki* in having only three rows of pinnules.

XENIA ELONGATA Dana. Plate 2, fig. 1.

Xenia elongata DANA, Zoophytes (1846) 606.

Xenia elongata WRIGHT and STUDER, Rep. Voy. Challenger **31** (1889) 252.

Xenia elongata KÜKENTHAL, Zoöl. Jahrb. **15** (1902) 649.

To this species I am referring several colonies. Usually two colonies are attached to each other by a short common base about 20 mm long. Stalk of each colony about 45 mm, 18 mm in diameter, usually divided into branches above, yellowish. When expanded, rounded terminal disc polyps of various sizes extend. Those at middle larger, those at periphery smaller and younger. Polyps rather slender with short tentacles. Polyp body very transparent, those full-grown measure from 14 to 20 mm long and 2.5 mm wide.

Tentacles short, with flattened axis, 5 to 7 mm long and 1 to 2 mm wide. Pinnules in two series, on either side of tentacles, with wide bare space between them. Each series composed of three, sometimes four, rows. There are from twenty to twenty-

four pinnules in a row, rather flat, short, pointed cones, 0.4 to 0.8 mm long and 0.2 to 0.3 mm wide. Those of outer aspect largest, those of innermost smallest.

Polyp body very transparent, with a bluish tinge. Tentacles brown on inside because of color of pinnules.

Nos. 3041–C and 3012–C, University of the Philippines zoölogical collection, from Puerto Galera Bay, Mindoro.

This form has been reported from Amboina.

XENIA FISHERI sp. nov. Plate 2, fig. 2.

Colony massive, stem smooth and undivided, almost as tall as wide, polyps of medium size, tentacles broad, pinnules elongate in three rows on either side of wide bare median area of inner surface of the tentacle, twelve to eighteen pinnules in a row.

Colony massive, wider than tall. Stem of colony smooth and very fleshy, usually 30 mm high with 28 mm basal diameter, often showing two opposite longitudinal grooves, but at times completely divided into two low branches. Expanded disc about 35 mm in diameter. The polyps, which have an umbellate arrangement, are very much crowded. They have bodies 8 to 12 mm high and 2 mm in diameter. The tentacles are 8 to 9 mm long and 1.6 mm wide at the base, fleshy, stout, and blunt-looking. The pinnules are in two lateral series of three rows, on each side of the very wide, bare, median, inner surface of the tentacles. Tentacles have been seen with only two rows of pinnules on either side. The bare portion is about 1.2 mm wide near the base, narrowing to about 0.32 in the tip. The pinnules are elongate, somewhat digitiform and nearly pointed, the largest being 0.5 to 0.9 mm long and 0.16 to 0.19 mm wide at the base. There are eighteen to twenty-two pinnules in a row.

Spicules are very numerous, densely packed under the ectoderm all over, oval or biscuitlike, flat discs often indented at the sides. They are 0.025 mm long and 0.01 mm wide.

In life the stalk is fleshy, the polyps are white, and the tentacles and pinnules are mostly light blue. The bases of the pinnules, however, have a rust-brown tinge.

Type: No. 3033–C, University of the Philippines zoölogical collection.

Locality: Plateau, Puerto Galera, Mindoro.

Tentacles wider and longer than in *X. elongata* and pinnules shorter than those of *X. umbellata.*

XENIA UMBELLATA Lamarck. Plate 2, fig. 3.

Xenia umbellata LAMARCK, Hist. Nat. Am. s. Vert. 2 (1816) 410.
Xenia umbellata SAVIGNY, Desc. de l'Egypte (Hist. Nat., Suppl.) 1 (1817) 228; Atlas Polypes, tab. 1.
Xenia umbellata SCHWEIGGER, Beob. naturh. Reisen (1819) 94.
Xenia umbellata MAY, Jena Zeitschr. f. Naturw. 33 (1899) 82.
Xenia umbellata ASHWORTH, Willey Zoöl. Results, pt. 4 (1900) 513.

Four colonies referred to this species. In two of them (3037–C) each colony is composed of two cone-shaped stems 30 mm long that arise from a short narrow common base about 10 to 12 mm in diameter. Each stem forms a fleshy stalk with a convex expanded disc about 20 mm wide. Polyps sparsely distributed. Oldest polyps at center of disc, the youngest toward periphery. Large polyps have bodies 10 mm long and 2 to 4 mm wide. Tentacles 8 to 9 mm long and 0.8 to 1 mm wide at base. Pinnules very long and slender, closely set in three rows on either side of the free middle line (outer series). The longest are 1.3 mm long and 0.13 mm wide.

In other two colonies (3023–C), main short stem 15 mm high and 10 mm near base, divides into two shorter stems 5 mm long, with a slightly convex disc from which free portions of polyps extend out. There are forty to fifty-five polyps on a single disc. Polyps not closely set, rather short, 10 to 12 mm long (including the tentacles). Tentacle axis cylindrical, about 5 to 6 mm long (excluding the pinnules) and 0.8 mm wide at base, tapering toward apex. Except the shorter ones at base and near tip of tentacles, pinnules very long and slender, 0.96 mm long and 0.13 mm wide, over six to eight times as long as wide, in three rows on either side of bare, middle, inner surface. There are about seventeen to twenty pinnules in a row.

Spicules present, most numerous on ectoderm of pinnules, biscuit-form or more or less circular, 0.014 to 0.018 mm long and 0.01 to 0.018 mm wide.

Rim of disc, as well as surface, beautiful sky blue. Outer surface of tentacles also sky blue but inner surface reddish brown. Entire colony appears in life grayish brown, sometimes bluish gray.

Nos. 3023–C and 3037–C, University of the Philippines zoölogical collection, from Plateau, Puerto Galera Bay, Mindoro.

This form has been recorded from the Red Sea, Indian Ocean (coast of East Africa), and Pacific Ocean (near New Britain). In our examples, the youngest and the smallest polyps I studied

measured as little as 2.2 mm in length and 0.8 mm in diameter, and yet these show a distinct pinnulation.

XENIA FLAVA sp. nov. Plate 2, fig. 4.

Colony branching, polyps large, stout, short-pointed cones in four rows on either side of attenuate tentacle, about twenty-two pinnules in a row.

Three short main stems arise from a common irregular base. Stems divide immediately into primary branches, which in turn give rise to secondary branches from which the free portions of polyps arise. Stems as well as the branches irregular in cross section with numerous longitudinal ridges and indentations, soft and weak-looking. Polyps also soft and very transparent, with bodies 13 to 15 mm long and 3 to 4 mm wide. Tentacles 6 to 8 mm long and about 1.2 mm wide at base, the entire inner median surface free from pinnules. This bare space is 0.9 mm wide near base, 0.4 mm at middle, and 0.16 mm near tip of tentacle. Pinnules in four rows on either side, in the form of small, pointed cones 0.48 mm long and 0.19 mm wide at base. There are about twenty-two pinnules in a row.

Spicules numerous everywhere just under the ectoderm, in form of oval or rounded, flat discs with a shallow constriction at opposite sides. Usually about 0.025 mm long and 0.0144 mm wide. Stem deep yellow; polyps yellowish brown.

Type: No. 3006–C, University of the Philippines zoölogical collection.

Locality: Sabang, Puerto Galera, Mindoro.

XENIA DELICATA sp. nov.

Stem branching, polyps small, delicate, and transparent, tentacles slender with four rows of tiny conelike pinnules on either side of the internal surface.

Colony small and delicate-looking, polyps small, tentacles slender. Stalk usually branched. From main base several primary branches arise, which in turn divide into two or three smaller branches from which free portions of polyps arise. Polyps have bodies 5 to 8 mm long and about 1 mm wide. Tentacles fingerlike, slender, 5 to 6 mm long and 0.8 mm wide, free throughout their extent. Pinnules in four rows on either side of inner surface of tentacles. Bare median region of tentacle about 0.5 mm basally, narrowing to 0.16 mm towards tip. Pinnules eighteen to twenty in a row, very small pointed cones,

0.32 mm long and 0.16 mm wide. Largest may be as long as 0.4 mm. Spicules present especially on external surface of tentacles and pinnules. Yellowish brown or greenish brown in life.

Type: No. 3034–C, University of the Philippines zoölogical collection.

Locality: Puerto Galera Bay, Mindoro.

This species is easily distinguishable from *X. hicksoni,* to which it is closest, in having a much more branched stem and in having four rows of pinnules on either side of the wide, bare, median portion of the inner surface of the tentacle.

XENIA MEMBRANACEA Schenk. Plate 2, fig. 7.

Xenia membranacea SCHENK, Abh. Senckenb. naturf. Ges. 23 (1896) 60.
Xenia membranacea MAY, Mitth. Mus. Hamburg 15 (1898) 18.
Xenia membranacea MAY, Jena Zeitschr. f. Naturw. 33 (1899) 86.
Xenia membranacea ASHWORTH, Willey Zoöl. Results, pt. 4 (1900) 512.

Base of colony spreading, often divided into several short, stumpy stems, about 20 mm high and 10 to 15 mm in diameter. Polyps of various ages much crowded on expanded umbellate disc. Young polyps found both at middle and periphery of disc. Free portion of polyp body 7 to 14 mm long and 1.5 to 3 mm in diameter. Tentacles short and stout, 4 to 6 mm long and 0.4 to 0.8 mm wide. Inner surface of tentacle almost covered by pinnules except near base where two series are narrowly separated by a bare strip 0.1 to 0.3 mm wide. Pinnules crowded in three to four rows in each series on each side of tentacle. Pinnules twenty-one in a row, elongate, nearly rounded at tips, the average size being 0.58 mm long and 0.2 to 0.3 mm wide at base.

Spicules very numerous, especially under ectoderm of tentacles and pinnules, biscuit-shaped or oval, 0.022 mm long and 0.014 mm wide.

Stalk yellowish in life, polyps light blue externally, pinnules yellowish gray. Large colonies are deep bluish green or grayish blue.

Nos. 3021–C and 3091–C, University of the Philippines zoölogical collection, Balatero Cove and Paniquian Island, near Puerto Galera, Mindoro.

Previously recorded from Ternate, New Britain, and Zanzibar. Hickson (1931) believes that this form is identical with *X. crassa* Schenk.

XENIA FELICIANOI sp. nov. Plate 2, fig. 6.

Massive colony, stem unbranched, polyp small at base but wide above, tentacles long and wide, pinnules long, slender with rounded ends in four rows of twenty-four to twenty-seven on either side.

Stalk single, thick, much wider apically than basally, height 30 mm, basal diameter 15 mm, diameter of disc 30 mm. Rim of capitulum finely wrinkled. Large polyps towards center of disc, younger and smaller towards periphery. Polyps thickly set, without dimorphism. Bodies of full-grown polyps 12 to 14 mm high, with narrow base, but wider body about 3 mm in diameter. Tentacles long, wide at base, gradually tapering towards tip, 8 to 10 mm long, 1.3 to 1.6 mm wide at base. Pinnules in four rows on either of wide, bare, inner, median surface of tentacle. There may be only three rows towards base. Pinnules twenty-four to twenty-seven in a row, long and narrow with rounded tip, 0.8 to 1.1 mm long and 0.16 mm wide. Those towards the base are shorter.

Spicules present, very numerous under ectoderm of tentacles and pinnules, oval, flat, thin discs about 0.0198 mm long and from 0.01 to 0.0126 mm wide.

Base white, capitulum bluish, tentacles green brown or yellowish.

Type: No. 3010–C, University of the Philippines zoölogical collection.

Locality: Second Plateau, Puerto Galera Bay, Mindoro.

This species has tentacles much wider than, and pinnules more than twice as long as, those of *Xenia schenki.*

XENIA AMPAROI sp. nov. Plate 2, fig. 8.

Colony medium-sized, stalk single or branched, cylindrical. Polyps medium-sized, tentacles proportionately short, pinnules elongate pointed, in four rows of eighteen to twenty-two, on either side of the tentacle.

Colony medium-sized, stalk single or branched or unbranched, cylindrical. Slightly laterally flattened, 40 mm high, with 15 mm basal diameter. Upper portion only slightly expanded, capitulum 20 to 25 mm wide. Side of stalk with a deep longitudinal groove on one side. Polyps thickly set, with bodies tall and transparent, as much as 20 mm long and 2 to 3 mm wide. Tentacles proportionately short and narrow, 5 to 6 mm long and 0.6 to 1 mm wide at base. Pinnules eighteen to twenty-two

in a row, long and slender usually, largest from 0.55 to 0.65 mm long and 0.13 to 0.15 mm wide at base. In one colony the pinnules are more or less truncated at tip, probably due to effect of preservation.

Spicules numerous, especially under ectoderm of external side of tentacles and pinnules, oval, rounded, or irregular flat discs, 0.019 mm long and 0.0105 mm wide.

Stalk light whitish yellow, polyps with slight bluish tinge, pinnules light or deep brown.

Type: No. 3051–C, 4 colonies, University of the Philippines zoölogical collection.

Locality: Second Plateau, Puerto Galera Bay, Mindoro.

This species resembles *X. felicianoi* in general color, but the polyps are smaller and the pinnules are shorter and much slenderer and pointed.

XENIA SCHENKI sp. nov. Plate 2, fig. 5.

Colony massive, stalk unbranched, polyps very tall, tentacles narrow, pinnules digitiform, of medium length, in four rows of eighteen to twenty on either side of the inner side of tentacles.

Colony massive, small or large. In a large specimen the stem is single, unbranched, tall and wide, about 70 mm high and 35 mm basal diameter, marked with wide, shallow, longitudinal grooves. Apical end of stem terminates in an expanded, convex disc, about 45 mm in diameter, almost hidden by the polyps. Polyps very tall and slender, many reaching 30 mm long. The body is too narrow for the extent, about 1 to 2 mm wide, except at its base where it may be much inflated to form a swollen portion 4 mm high and 6 mm in diameter. Polyp body is soft and nearly transparent. Tentacle axis of medium length, slender and cylindrical, 5 to 7 mm long, firm, widest at the middle where it is about 0.72 mm wide. One colony has very narrow tentacles about 8 mm long and 0.06 mm wide; each tentacle is almost entirely covered by pinnules on the inside except toward the base where there is a narrow base region about 0.2 mm wide. Four rows of pinnules are present on either side, which almost fill its entire median surface, except for a very narrow bare median area about 0.3 mm wide. There are about eighteen to twenty pinnules in a row. These are closely set, stumpy, about 0.4 to 0.06 mm long and 0.2 to 0.32 mm wide.

Spicules numerous under ectoderm of tentacles and pinnules few on body, biscuit-shaped, oval or narrow thin discs, 0.018 to 0.021 mm long and 0.0077 to 0.0112 mm wide.

Color is whitish yellow or light gray.

Type: No. 3032–C, University of the Philippines zoölogical collection.

Locality: Plateau and Medio Island, Puerto Galera, Mindoro.

XENIA SANSIBARIANA May. Plate 3, fig. 1.

Xenia sansibariana MAY, Jena Zeitschr. f. Naturw. **33** (1899) 87.
Xenia sansibariana KÜKENTHAL, Zoöl. Jahrb. **15** (1902) 655.

I am referring to this species several colonies in our collection. The stem of one, which is unbranched, is more or less dumb-bell-shaped, slightly compressed, with a length of 35 mm, a long basal diameter of about 20 mm, and a small diameter of 15 mm. The distal portion of the stem is in the form of an expanded disc with an elliptical outline, 35 mm long and 18 mm wide. The polyps are crowded. Most of the larger ones are at the center of the disc, the smaller and younger ones mostly at the periphery, although a number are located among the older ones at the center. The larger polyps have bodies 23 to 25 mm long and 3 mm wide. These are quite transparent so that the mesenteries and mesenterial filaments can be readily seen. Ten tentacles are tongue-shaped, about 9 mm long and 1.3 mm wide near the base. The pinnules are in two series of five rows each on either side of the bare median inner surface of the tentacles. This bare space is about 0.64 mm near the base and 0.24 mm towards the tip. The pinnules are long, narrow, and pointed. These are longest at or above the middle of the tentacle where they are about 0.8 mm long and 0.14 wide at the base. There are twenty-eight to thirty pinnules in a row. Spicules absent.

Stalk, body, and axis of tentacle white, pinnules deep or light brown. In life, the colony in position is brownish in appearance.

Nos. 3022–C and 3047–C, University of the Philippines zoölogical collection, from Puerto Galera Bay, Mindoro.

This species was first described by May from materials collected from Zanzibar (Indian Ocean). The type is in the Berlin Museum.

XENIA MAYI sp. nov. Plate 3, fig. 2.

Colony massive, stem low, spreading, single or divided, polyps large, tentacles with five rows of elongate pinnules, twenty-four to thirty-two in a row.

Usually two stalks are joined by a low, wide, common base 20 mm high and 30 mm in diameter. The stalk of each is about

30 mm high and 20 mm in diameter, smooth or marked by a fine or rough longitudinal ridge. On one colony two stalks are fused more or less throughout their length, there is a deep, wide, and smooth groove between them. Polyps are thickly set, the bases of the bodies in close proximity with each other. Young polyps are found both at the periphery and at the middle of the capitulum. Polyps have bodies 12 to 14 mm long and 2 to 3 mm wide. Tentacles are of medium size, almost free throughout their length, 7 to 9 mm long and 1.28 to 1.44 mm wide at the base. Pinnules are elongate, filiform and pointed or rounded at the tips, in five rows on either side of the bare, inner, median surface of the tentacles. The longest, which are toward the middle of the tentacle, are from 0.8 to 0.96 mm long and 0.16 mm wide. Those towards the base are shorter, a few in the form of rounded warts. There are twenty-four to thirty-two pinnules in a row.

Spicules are present everywhere under the ectoderm, especially numerous on body and external surface of the tentacles and pinnules. These are thin, oval or rounded, flat discs with very slight indentations on two sides. They are mostly 0.0216 mm long and 0.0108 to 0.0144 mm wide.

In life the stalk is very light tan, the polyps are light sky blue, and the pinnules are gray.

Type: No. 3054–C, University of the Philippines zoölogical collection.

Locality: Medio Island, near Puerto Galera, Mindoro.

This species resembles *X. sansibariana* in having five rows of elongated pinnules on either side of the tentacles. The presence of spicules and the blue-gray color mark it as a new species.

XENIA TRIPARTITA sp. nov. Plate 2, fig. 9.

Colony with flat spreading stolon, polyps small, thick, tentacles triangular in cross section, with three rows of pinnules, one on the median inner surface and two on the lateral external surface, seven or eight pinnules in a row.

Unlike most species of *Xenia,* the base of the colony is a flat spreading stolon closely applied to coral stones, about 3 to 5 mm thick, irregular in form and extent. Although unusual in form, its stolon agrees with other members of the Xeniidæ in being an extensive cœnenchyme mass uniting the bases of polyps, and pierced by an elaborate and extensive canal system.

Polyps small, more retractile than in most members of the Xeniidæ, not closely set, covering entire outer surface of stolon.

Young polyps situated at middle as well as at edge of spreading base. Polyps short, stout, smooth, and thick walled, about 4 mm high (including tentacles) and 1 to 1.3 mm wide. Tentacles short, thick and fleshy, more or less triangular in cross section with apex of triangle forming internal median surface. They are 1.6 to 2.3 mm long and 0.5 to 0.65 mm wide at base, measured from outside. Three rows of pinnules present, one on median internal surface and one each on lateral external surface of tentacle. In internal row, five to six pinnules, on two external rows, seven or eight. Pinnules stout, thick cones, 0.32 to 0.48 mm long and 0.18 to 0.22 mm wide.

Spicules very numerous, not only in mesoglœa under the ectoderm of polyps but also in mesenteries and in cœnenchyme of stolon. They are oval, flat, thin discs about 0.0216 mm long and 0.0112 mm wide.

In life the stolon and the body of polyps are pale green, and the tentacles greenish blue.

Type: No. 3038–C, University of the Philippines zoölogical collection.

Locality: Sabang and Puerto Galera Bay, Mindoro.

Genus HETEROXENIA Kölliker

Heteroxenia KÖLLIKER, Festschrift der Physik.-Medicin. Gessellsch., Wurzburg (1875); BOURNE, Phil. Trans. Royal Soc. London (1895) 186; ASHWORTH, Qr. Journ. Mic. Sci. 42 (1899); HICKSON, Barrier Reef Exp. No. 5 4 (1931).

Since Kölliker described the type species of the genus, *Heteroxenia elizabethæ*, in 1875, the existence or nonexistence of polyp dimorphism in the Xeniidæ has given various workers grave concern. The existence of this dimorphic xeniid in Philippine waters was first pointed out by Light (1915), who studied it carefully, although he did not publish any detailed description of the species. When this form was brought to my attention, I decided to study it further in the Puerto Galera region where it is abundant. A cursory examination of the xeniid fauna of Puerto Galera Bay revealed an enormous number of representatives of this genus. As there has been much controversy about it, I took pains to study *Heteroxenia* for three successive summers right at the coast, working on living as well as freshly killed, properly fixed, specimens.

Four xeniid forms have been known to be dimorphic; namely, *H. elizabethæ* Kölliker, *H. capensis* Hickson, *H. rigida* (May), and *H. uniserta* (Kükenthal). The first has been known in the

Philippines, and other dimorphic forms have been found and are here reported as new species of *Heteroxenia.* It should be emphasized that each new species described is based on the study of many specimens, although only one accession number may be named. Other workers are welcome to duplicates of these specimens in case of doubt as to the validity of any species. A short diagnosis and a key to the species from the Philippines follow.

Heteroxenia includes species of the Xeniidæ with two kinds of zooids, autozooids, and siphonozooids present, all arising at the same level from the terminal expanded portion of the stalk.

Key to the Philippine species of Heteroxenia Kölliker.

a^1. Pinnules in the form of rounded knobs.
- b^1. Pinnules in two rows on either side of the inner surface of the tentacle which is free throughout .... *H. minuta* sp. nov.
- b^2. Pinnules in three or four rows, tentacle not free towards the apex. *H. palmæ* sp. nov.

a^2. Pinnules more or less elongated, rounded or pointed at tip.
- b^1. Pinnules in two or three irregular rows........ *H. medioensis* sp. nov.
- b^2. Pinnules in three very regular rows.
  - c^1. Pinnules less than 3.5 times longer than wide.
    - d^1. Tentacle short and narrow, pinnules crowded. *H. elizabethæ* Kölliker.
    - d^2. Tentacle long and wide, pinnules not crowded. *H. philippinensis* sp. nov.
  - c^2. Pinnules more than 3.5 times longer than wide.
    - d^1. Tentacle axis long but wide, pinnules four to five times longer than wide, rounded at end........ *H. mindorensis* sp. nov.
    - d^2. Tentacle axis long and slender, pinnules 7 times longer than wide, more or less pointed at end........ *H. lighti* sp. nov.
- b^3. Pinnules in four or five rows........ *H. pinnata* sp. nov.

HETEROXENIA MINUTA sp. nov. Plate 4, fig. 8.

Colony stunted, base triangular, polyps small, tentacles short, narrow, free throughout, pinnules in form of rounded knobs, in two rows on either side, fourteen to sixteen in a row.

Colonies with a base decidedly triangular with apex of triangle attached to rock. Base of triangle in form of expanded disc more or less circular in outline. Base about 20 mm high and 15 mm at expanded upper portion. Disk with slightly convex outer surface from which autozooids and siphonozooids extend out. Autozooids set far apart, spaces between them packed full of siphonozooids. Autozooids smaller than any other species of *Heteroxenia* described, bodies 4 to 5 mm long and 1 to 1.5 mm wide. Tentacles 5 to 6 mm long and 0.8 to 0.9 mm wide, with two rows of rather stout, rounded pinnules on either side of

free middle line of inner side. Bare region about 0.2 mm at base, fourteen to sixteen pinnules in a row, 0.3 to 0.4 mm long and 0.2 to 0.3 mm in diameter.

As in other species of *Heteroxenia,* spicules numerous under ectoderm of body of polyps and tentacles, most abundant on outer surface of tentacles and on pinnules. These are biscuit-shaped or oval bodies, 0.018 mm long and 0.014 mm wide.

Siphonozooids small, about 3 mm long and 1.4 mm wide at outer end. Tentacles very short, 0.2 mm long, hardly protruding beyond the apical end of body of zooids. Spicules also found in these zooids, more numerous apically.

Autozooids light fleshy in color, and siphonozooids have chalk white terminal portions.

Type: No. 3019–C, University of the Philippines zoölogical collection.

Locality: Puerto Galera Bay, Mindoro.

This species differs from other species of *Heteroxenia* in having only two rows of much-rounded pinnules.

Heteroxenia capensis of Hickson has usually only one row of pinnules. In some badly contracted ones, the pinnules may appear as if in two rows. The number of pinnules, however, is much less, eight to ten, and the color is brown.

HETEROXENIA PALMÆ sp. nov. Plate 3, fig. 3.

Stalk columnar, single, polyps of medium size, not crowded, tentacles long, slender, not entirely free, pinnules in the form of rounded knobs, in three or four rows, sixteen to eighteen in a row.

Stalk of colony single, undivided, long, columnar, 43 mm long and 15 mm in diameter, marked by deep longitudinal grooves. Terminal disc much rounded, almost ball-like from which two kinds of zooids arise. Autozooids far apart, 10 to 11 mm long and 2 to 2.5 mm wide. Young polyps mostly located along edge of disc. Polyp body marked with eight deep longitudinal grooves. Tentacles slender, 6 to 7 mm long and 0.8 to 1 mm wide. Pinnules rounded knobs, arranged more or less irregularly in two series on either side of tentacle. Basally there are only three rows of very small pinnules, in fact, those at base of tentacles can hardly be discerned. Beginning about middle of tentacle, however, the number of rows in a series increases to four and the inner surface of tentacle is practically covered. There are from sixteen to eighteen pinnules in a row (outermost series). Pin-

nules much crowded and rounded, about 0.4 mm long and 0.2 mm wide.

Siphonozooids about 2.5 to 3 mm high and 0.7 to 0.9 mm wide. Tentacles mere knobs and without pinnules. They are eight to ten times as numerous as the autozooids.

Spicules present, most numerous on ectoderm of both kinds of zooids, especially apically.

In life, base and autozooids fleshlike in color. Pinnules, however, are brown. The siphonozooids are white.

Type: No. 3027–C, University of the Philippines zoölogical collection.

Locality: Puerto Galera Bay, Medio Island, Mindoro.

This differs from other *Heteroxenia* in having very short, much-rounded pinnules, which are in three rows basally and in four rows apically. The presence of the distinct longitudinal furrows of the polyp body and on the stalk is also very characteristic. It cannot be confused with *Xenia intermedia,* which has a similar type of pinnulation, because of its longer tentacles and wider but shorter polyp bodies.

This species is named for Dr. Rafael Palma, president of the University of the Philippines.

HETEROXENIA MEDIOENSIS sp. nov.

Colony small or large with columnar base, polyps of medium size, tentacles free throughout, pinnules of variable length, rounded, short or elongate, in two or three rows, fourteen to eighteen in a row.

Several colonies with columnar slightly flattened stalks about 18 to 30 mm high and with basal diameters 14 by 10 mm. Upper portion of stalk an expanded disc, elliptical in cross section, with the long diameter 23 to 30 mm and the short diameter 15 to 20 mm. Stalk and rim of disc marked by numerous shallow vertical ridges. Large polyps towards the center of disc, younger ones at the edge. Largest polyps have bodies 6 to 9 mm long and 2 mm in diameter. Tentacles 5 to 6 mm long and 0.64 mm wide at base. Pinnules arranged in two series of two or three very irregular rows on either side of bare median inner space of tentacles. In many polyps examined neighboring pinnules are attached to each other. Bare space between two series about 0.3 mm wide on greatest extent of tentacle. Pinnules elongate, rather stout, very variable in length. Longest 0.54 to 0. 64 mm long and 0.16 to 0.2 mm wide. Shorter ones 0.29 mm long and 0.13 mm wide. Those at base are mere knobs.

Fourteen to eighteen pinnules are present in a row (outer aspect).

Siphonozooids closely packed between bases of autozooids. They are about 2.8 mm long and 0.8 mm wide. Apical end only slightly expanded. Here diameter is about 1.08 mm. Tentacles mere slight projections without any pinnules.

Spicules present, most numerous apically in ectoderm of both autozooids and siphonozooids. Stalk and siphonozooids white. Autozooids very pale yellow or light grayish.

Type: No. 3001–C, University of the Philippines zoölogical collection.

Locality: Medio Island, Puerto Galera, Mindoro.

HETEROXENIA ELIZABETHÆ Kölliker. Plate 4, fig. 7.

Heteroxenia elizabethæ KÖLLIKER, Festschrift der Physic.-Med. Gessellsch. Wurzburg (1874) 13; BOURNE, Phil. Trans. Roy. Soc. London 186–B (1895) 476; ASHWORTH, Qr. Journ. Mic. Sci. 42 (1899) 284.

I am referring to this species five colonies with the stem single or divided, 20 mm high and 13 mm in basal diameter. The slightly expanded terminal disc from which free portions of polyps arise is from 18 to 25 mm in diameter. Autozooids closely set, between successive ones there being only one to three small siphonozooids. Autozooids have polyp bodies 5 to 5.5 mm long and 1.5 to 2 mm in diameter. Tentacle short and narrow, 4 to 5 mm long and 0.3 mm wide at base with three rows of pinnules on either side of median bare region of inner surface. There are sixteen to eighteen pinnules in a row, elongate, fingerlike, and rounded at end. Those towards middle and upper part of tentacles are 0.5 to 0.6 mm long and 0.14 to 0.2 mm in diameter, three to four times as long as wide; those below are 0.3 mm long and 0.14 mm wide.

In some specimens (3043–C) the pinnules are stouter, only twice as long as wide, and the two series of pinnules are closer together.

Siphonozooids 1.2 to 1.6 mm long and 0.48 mm in diameter. Upper end slightly expanded, 0.8 to 0.9 mm in diameter, with eight knoblike pinnuleless tentacles.

Spicules numerous all over both types of zooids.

In life the colony appears light gray or ashy gray, sometimes grayish brown.

Nos. 3018–C and 3035–C, University of the Philippines zoölogical collection; from Medio Island and Second Plateau, Puerto Galera Bay, Mindoro.

Although the specimens at hand have shorter polyp bodies than those described by Bourne and Ashworth, the dimensions and proportion of other parts as well as the color agree with typical *H. elizabethæ.* Our specimens, however, have fewer pinnules in a row, sixteen to eighteen. This is the first locality record of this species in the Philippines. It has previously been recorded from Zanzibar (Indian Ocean) and Port Denison (Pacific Ocean).

HETEROXENIA PHILIPPINENSIS sp. nov. Plate 4, figs. 1 and 5.

Colony tall, stalk columnar, polyps slender, tentacles long, pointed, free throughout, pinnules of medium length, rounded, in three rows, twenty-four to twenty-seven in a row.

Species described from one medium-sized colony, among the many we have in our collection. Stem columnar, 43 mm high, with a basal diameter of 13 mm. Apical portion of stem in the form of an expanded, oblong convex disc 34 mm long and 23 mm wide. Autozooids and siphonozooids arise all over the surface as well as from edge of disc. Polyps have slender bodies, the full-grown being about 20 mm long and 2 mm in diameter, semitransparent, with gonads located at bases. Tentacles from 8 to 10 mm long. At base and at middle, they are about 0.96 mm wide, narrowing gradually to a point apically. Pinnules in two series of three rows each on either side of very wide, bare, median, inner surface of tentacles. Those toward the base short, stumpy, and rounded, 0.32 mm high and 0.16 mm in diameter or even smaller. Towards the end of the tentacles they are longer, 0.5 to 0.7 mm long and 0.24 mm in diameter. There are from twenty-four to twenty-seven pinnules in a row.

One colony collected from Sabang Cove, Puerto Galera, has a rather low spreading base. Also polyps have shorter bodies although all other measurements are identical.

Siphonozooids from 2 to 2.9 mm high with a basal diameter of 0.64 mm. Apically they broaden to about 1.2 mm. Tentacles, which are slightly iridescent, more prominent than in other species. They are 0.48 mm wide and 0.5 mm high, more or less triangular in cross section.

Spicules numerous all over, in mesoglœa, just beneath ectoderm of autozooids and siphonozooids. These are oval or irregularly rounded thin discs, 0.018 mm long and 0.014 mm wide.

In life polyps are light brown due to color of pinnules. Stem and body are whitish. Polyp bodies marked with eight very fine longitudinal brownish lines with broken cross lines of the same

hue, giving it a checkered appearance. When left in formalin for a long time the entire colony turns yellowish green. The animals are found attached to pieces of dead coral.

Type: No. 3014–C, University of the Philippines zoölogical collection.

Locality: Puerto Galera Bay and Sabang, Mindoro.

This species has much longer polyp bodies and tentacles than most species of *Heteroxenia.*

HETEROXENIA MINDORENSIS sp. nov. Plate 3, figs. 5 and 6; Plate 4, fig. 3.

Colony tall, polyps large, not crowded, tentacles large, axis narrow, pinnules elongate but rounded at end, four to five times longer than wide, in three rows, twenty to twenty-four in a row.

Several tall and slender colonies with high columnar stalks, the largest of which is 25 mm long and 15 mm in its greatest diameter, with circular cross section. Expanded terminal disc also more or less circular in outline, with a rounded surface from which free portions of polyps stand out. Autozooids seem far apart and not crowded. These vary in size; at the center of the disk they are large, at the periphery small. Polyps on the average measure 9 to 11 mm long and 2 to 2.5 mm wide. Axis of tentacles 7 to 8 mm long and 0.9 to 1.2 mm wide at base. Pinnules in two series on either side of bare middle portion of tentacles, there being three distinct rows in a series. Pinnules twenty to twenty-four in a row (outer aspect), elongate, but stout and rounded. They are 0.9 mm long and 0.2 mm wide. Ratio between length and width is 4 or 5 to 1. Those near the base are shorter.

Siphonozooids 2.5 to 3 mm long and 0.5 to 0.6 mm wide with an expanded end about 1 to 1.3 mm wide. Tentacles, free from pinnules, mere knobs about 0.3 mm long.

Spicules present, most numerous under external ectoderm of tentacles of two kinds of polyps.

Stem fleshy, but rest of colony has a light sky-blue tinge.

Type: No. 3036–C, University of the Philippines zoölogical collection.

Locality: Puerto Galera Bay, Mindoro.

This species differs from *Heteroxenia lighti* in having a cylindrical base, less-crowded polyps with taller and wider bodies, and stouter and shorter pinnules that are rounded at the end.

HETEROXENIA LIGHTI sp. nov. Plate 3, fig. 7.

Colony massive, base wide and short, polyps small and crowded, tentacle long and wide, pinnules very long, almost pointed, about

seven times longer than wide, in three rows, twenty or twenty-one in a row.

Colony massive, attached to a piece of coral by means of a short, thick, wide, and unbranched stem, circular in cross section, 28 mm high and 35 mm in its largest diameter. Free portion of autozooids very closely set, so that it is often hard to see the small and short siphonozooids between them. Polyp body of autozooids rather small, about 4 to 5 mm long and 1 to 2 mm wide, marked with numerous irregular rings around it. Axis of tentacle, on the average, about 8 mm long and 1.3 mm wide. Pinnules in three distinct and beautifully arranged rows on either side of inner surface of tentacle, leaving a rather wide bare space at median portion. There are twenty or twenty-one pinnules in a row, very long, slender, and much attenuated, almost pointed, 1.3 mm long and 0.2 mm wide. Length about seven times the width. Those near the base are shorter.

Siphonozooids long and slender, 4.5 mm long and 0.7 mm wide. At apical region they are slightly expanded, having here a diameter of 1.5 mm. Tentacles mere knobs, 0.32 mm long and without any trace of pinnules.

Body of autozooids and siphonozooids whitish, but pinnules are greenish yellow. Spicules present, most numerous on autozooids and apical portion of siphonozooids. Autozooids are yellowish; siphonozooids are white.

This species differs from *H. elizabethæ* in having a shorter polyp body, much longer tentacles, and larger, longer, and stouter pinnules.

Type: No. 3024–C, University of the Philippines zoölogical collection.

Locality: Plateau, Puerto Galera Bay, Mindoro.

This species is named for Prof. S. F. Light, who has contributed much to the knowledge of Philippine alcyonarians.

HETEROXENIA PINNATA sp. nov. Plate 4, fig. 9.

Colony large, stalk columnar, polyps large with thick bodies, tentacles shorter but very wide, pointed; pinnules long, narrow, pointed, in four or five rows, thirty-four in a row.

Colony massive, with a thick, tall, columnar, fleshy stem, 70 mm high and 30 mm in diameter, or larger. Long diameter of apical expanded disc 50 mm; short diameter, 35 mm. Two kinds of zooids are much crowded. Autozooids with thick bodies, 12 to

14 mm long and 1.3 to 2 mm wide. Tentacles relatively short and wide with a very short, narrow, terminal portion. Tentacle axis 8 mm long and with a 1.3-mm basal diameter. Pinnules in two series of four or five rows each, leaving a wide, bare, median surface between two series, except at very tip where they are together. Pinnules thirty-four in a row, external aspect much crowded, slender, narrow, and sharply pointed. Most are 0.88 mm long and 0.19 mm wide at base.

Siphonozooids rather slender, 4 to 5 mm high and 0.64 mm wide for greatest extent. Terminal portion where pinnuleless tentacles are situated slightly expanded, about 1.44 mm in diameter. Tentacles 0.6 mm long and 0.32 mm wide, with a tiny brown point on external surface.

Spicules present, few on body of autozooids and siphonozooids, but numerous on tentacles and pinnules.

Pinnules intense brown. Body of polyps and axis of tentacles white.

Type: No. 3017–C, University of the Philippines zoölogical collection.

Locality: Plateau, Puerto Galera, Mindoro.

This is the most numerous *Heteroxenia* in Puerto Galera Bay, growing on old and new pieces of coral. It can easily be recognized among other species because of the featherlike tentacles. The crowded, very numerous, slender, and pointed pinnules constitute a distinctive character.

Genus CESPITULARIA Milne-Edwards

Cespitularia MILNE-EDWARDS, Hist. Nat. des Corall. 1 (1857) 126. Type, *Cornularia multipinnata*.

Cespitularia MAY, Jena Zeitschr. f. Naturw. 33 (1899) 89.

The genus *Cespitularia* was established by Milne-Edwards (1857). It was May (1899), however, who gave a clear definition of the genus through his diagnosis: "Xeniiden von baumformigen Habitus." Unlike *Xenia*, the colony is decidedly branching, and the polyps do not arise from a sharp terminal disc, but at different levels of the stem. According to Kükenthal (1902) there are five void species of the genus; namely, *C. mollis* (Brunden), *C. taeniata* May, *C. coerulea* May, *C. subviridis*, and *C. multipinnata* (Quoy and Gaimard). Recently Thomson and Dean (1931) described a new species, *C. simplex*, from the Siboga Collection. Of these I have found only *C. cœr-*

ulea in the Puerto Galera region in addition to two forms that are apparently new. The following is a short diagnosis of the genus and a key to the three Philippine species of *Cespitularia*.

Cespitularia is a genus of the Xeniidæ without polyp dimorphism, with a treelike habit, the colony decidedly branching, the polyps not arising from a sharp terminal disc but at different levels of the stem.

Key to the Philippine species of Cespitularia Milne-Edwards.

a^1. Pinnules in four rows on each side of the tentacle. *C. quadriserta* sp. nov.

a^2. Pinnules in one row on each side of the tentacle.

- b^1. Tentacle 3.5 to 4 mm long, fourteen to eighteen pinnules in a row. *C. cœrulea* May.
- b^2. Tentacle 1.2 to 1.6 mm long, four to seven pinnules in a row. *C. hypotentaculata* sp. nov.

CESPITULARIA QUADRISERTA sp. nov. Plate 4, fig. 2.

Colony dichotomously branched, polyps and tentacles long, tentacles with four rows of conical, wart-shaped pinnules, twenty-four to twenty-six in a row.

Colony consists of several primary basal stems, divided, stout, fleshy, and with prominent longitudinal grooves. Terminal branches short, grouped in threes, arising from secondary or tertiary stems. Polyps arise from different levels of terminal branches; those toward apex largest, those toward base smaller and younger. Majority of full-grown polyps are about 15 mm long (including tentacles). Body of polyps thin, transparent, soft, 9 mm long and 1.5 to 2 mm wide. Tentacles slender and pointed, about 4 to 6 mm long and 0.8 mm wide at base, with cylindrical axis tapering gradually toward apex. Each tentacle bears on either side four rows of regularly arranged pinnules, leaving a clear and distinct space at middle of inner surface. There are twenty-four to twenty-six pinnules in a row (outer series). Pinnules small, pointed cones, 0.2 mm long and 0.1 mm wide at base, longest at middle of tentacle. Proximally and distally they are smaller. Those at base of tentacles are mere knobs or warts. Pinnules of innermost series (toward the middle line of tentacles) usually smaller than those of most external series. Spicules noticeably absent.

When the tentacles are open, the colony appears light brown; but when the tentacles are partly closed the colony looks yellowish green. Base and stems of colony and body of polyps light flesh color. Tentacles yellowish green externally, but the pin-

nules brownish. General color of colony varies according to the state of contraction of tentacles.

Type: No. 3028–C, University of the Philippines zoölogical collection.

Locality: Puerto Galera Bay and Sabang, Mindoro.

Extensive masses of this species cover old corals just below the low-tide line of Puerto Galera Bay. The only species with which this may be confused is *C. multipinnata*. In the latter, however, the pinnules, which are in three irregular rows, cover the entire inner surface of the tentacle. In the present species the pinnules are in four very regular rows extending from the base to the tip of the sides of the tentacles, leaving a large median portion of the inner surface of the tentacle free from pinnules. The mode of branching is more or less similar to that of *C. coerulea*. In *C. coerulea*, however, there is only one row of pinnules on each side of the tentacle and these are much longer.

This species has longer polyps and longer tentacles than any *Cespitularia* that has been previously described. The pinnules, however, are smaller than those of the other known species.

CESPITULARIA HYPOTENTACULATA sp. nov. Plate 4, fig. 4.

Base spreading, stalk single or branched, tentacles short, with one row of wartlike pinnules, four to seven in a row.

From a spreading base, 35 by 20 mm wide and 22 mm high, six or more cylindrical, single or branched stems, 25 mm high and 10 mm wide, arise. Polyps arise from different levels of stems. Full-grown polyps have long bodies, 6 to 8 mm long and 1.7 to 2 mm wide. Tentacles relatively short, 1.2 to 1.6 mm long and 0.5 to 0.6 mm wide. Only one row of very low, wide, wartlike pinnules on either side of median inner surface of tentacle present. There are from four to seven pinnules in a row.

Spicules absent. In life, stem is bluish and polyps are brown.

Type: No. 3072–C, University of the Philippines zoölogical collection.

Locality: Near Paniquian Island, in Northwest Channel leading to Puerto Galera Bay, Mindoro.

This species has tentacles of the same length as those of *C. taeniata*, but the polyp body is much taller and wider. The polyp body and the number of pinnules are identical with those of *C. subviridis*, but the pinnules are much smaller; in fact, those situated below cannot be seen very well.

CESPITULARIA COERULEA May. Plate 4, fig. 6.

Cespitularia coerulea MAY, Mitth. Mus. Hamburg 15 (1898) 21.
Cespitularia coerulea MAY, Jena Zeitschr. f. Naturw. 33 (1899) 90.
Cespitularia coerulea KÜKENTHAL, Zool. Jahrb. 15 (1902) 659.

Colony branched, growing from a base 30 mm high and 20 mm broad. This gives rise to three or four stems that divide dichotomously into cylindrical branches from different levels of which the polyps arise. Polyps have bodies 4 to 6 mm high and 1 to 1.5 mm in diameter. Tentacles 3.5 to 4 mm long and 0.48 mm wide. Pinnules arranged in one row on either side of tentacle, which is free throughout its length. Above they are elongate, short, fingerlike, about 0.4 to 0.6 mm long and 0.17 mm wide. Below they are shorter. There are fourteen to eighteen pinnules in a row. Spicules absent. Color light flesh tinged with pale blue. After being kept in formalin for some time the specimen turns brownish yellow.

No. 3068–C, University of the Philippines zoölogical collection, from Sabang, near Puerto Galera, Mindoro.

Genus SYMPODIUM Ehrenberg

Sympodium EHRENBERG, Die Korallentiere des roten Meeres (1834) 61; DANA, Zoophytes (1846) 608; MILNE-EDWARDS, Hist. Nat. des Corall. 1 (1877) 110; KLUNZINGER, Die Koralltiere des roten Meeres 1 (1877) 42; WRIGHT and STUDER, Challenger Report 31 (1889) 270; MAY, Jena Zeitschr. f. Naturw. 33 (1899) 47; NUTTING, Proc. U. S. Nat. Mus. 35 (1909) 686; HICKSON, Great Barrier Reef Exp. No. 5 4 (1931) 174.

The genus *Sympodium* was established by Ehrenberg in 1834. The best diagnosis of the genus was given by Wright and Studer (1889) as follows: "The basis of the colony is a thin but leathery membrane from which the pretty numerous polyps arise; these are short, retractile, and are sunk deeply into the basal membrane. The spicules are very small and disc-like."

No less than twenty-seven different animals have been described as belonging to the genus. Five of these, however, do not properly belong to the genus.

I am acquainted with only one form of *Sympodium;* namely, *S. coeruleum* Ehrenberg. Basing my opinion on this alone, I cannot subscribe to the suspicion of Hickson that "*Sympodium* may be only young growth stages of species of Xenia." I have examined this form from various regions in Puerto Galera Bay and I have not found any indication of them transforming to a stage further than as they are described below. There has been much controversy as to where this genus should be placed. Due

to the presence of numerous biscuitlike sclerites all over the colony and due to the existence of numerous pinnules on the tentacles, I am following Hickson in placing this genus under the Xeniidæ temporarily until we know more of its detailed anatomy.

SYMPODIUM COERULEUM Ehrenberg.

Sympodium coeruleum EHRENBERG, Die Korallentiere des roten Meeres (1834) 21; KLUNZINGER, Die Korallenthiere des roten Meeres (1877) 42; WRIGHT and STUDER, Challenger Report **31** (1889) 271; MAY, Jena Zeitschr. f. Naturw. **33** (1899) 51; KÜKENTHAL, Koralltiere des Rothen Meeres, Jena Denschr. **11** (1904) 39; THOMSON and HENDERSON, Trans. Linn. Soc. **13** (1909) 168.

From a very thin basal membrane numerous polyps arise. Base usually encrusted around old dead branches of stag-horn coral, *Madrepora.* Polyp bodies when extended 0.7 to 1 mm high and 0.6 to 0.8 mm wide. Tentacles 1.2 to 1.4 mm long and 0.22 to 0.32 mm wide at middle, more or less rounded and blunt. Pinnules rounded stumpy, in numerous rows around tentacle. They are usually 0.096 mm high and 0.072 mm wide. Sclerites uniformly distributed throughout, in form of tiny, oval discs, like red blood corpuscles, 0.015 mm long and 0.01 mm wide. Colony light blue or sky blue.

Polyps rather contractile. When not properly anæsthetized before fixation, the polyps become partly sunk in small pits from 0.8 to 1.7 mm apart, and only the tips or two-thirds of the tentacles are visible from the surface. The base is usually less than 1 mm thick, but when the colony is fully contracted it may be as thick as 3 mm. This form is very common in Puerto Galera Bay and Sabang Cove, Mindoro, Philippines.

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ILLUSTRATIONS

Plate 1

TENTACLES OF XENIA, DORSAL AND VENTRAL VIEWS, × 8

FIG. 1. *Xenia kükenthali* sp. nov.
2. *Xenia lilliezæ* sp. nov.
3. *Xenia puerto-galeræ* sp. nov.
4. *Xenia danæ* Verrill.
5. *Xenia intermedia* sp. nov.
6. *Xenia viridis* Schenk.
7. *Xenia blumi* Schenk.
8. *Xenia crassa* Schenk.
9. *Xenia cylindrica* sp. nov.

Plate 2

TENTACLES OF XENIA, DORSAL AND VENTRAL VIEWS, × 8, EXCEPT FIG. 9

FIG. 1. *Xenia elongata* Dana.
2. *Xenia fisheri* sp. nov.
3. *Xenia umbellata* Lamarck.
4. *Xenia flava* sp. nov.
5. *Xenia schenki* sp. nov.
6. *Xenia felicianoi* sp. nov.
7. *Xenia membranacea* Schenk.
8. *Xenia amparoi* sp. nov.
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Plate 3

TENTACLES, ETC., OF VARIOUS GENERA, × 8

FIG. 1. *Xenia sansibariana* May; tentacles, dorsal and ventral views.
2. *Xenia mayi* sp. nov., tentacles, dorsal and ventral views.
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5. *Heteroxenia mindorensis* sp. nov.; a siphonozooid.
6. *Heteroxenia mindorensis* sp. nov.; tentacles, dorsal and ventral views.
7. *Heteroxenia lighti* sp. nov.; tentacles, dorsal and ventral views.

PLATE 4

TENTACLES, ETC., OF VARIOUS GENERA, × 8

FIG. 1. *Heteroxenia philippinensis* sp. nov.; tentacles, dorsal and ventral views.
2. *Cespitularia quadriserta* sp. nov.; tentacles, dorsal and ventral views.
3. *Heteroxenia mindorensis* sp. nov.; tentacles, dorsal and ventral views.
4. *Cespitularia hypotentaculata* sp. nov.; a polyp.
5. *Heteroxenia philippinensis* sp. nov.; *a*, siphonozooid; *b*, autozooid.
6. *Cespitularia cœrulea* May; tentacles, dorsal and ventral views.
7. *Heteroxenia elizabethæ* Kölliker; tentacles, dorsal and ventral views.
8. *Heteroxenia minuta* sp. nov.; tentacles, dorsal and ventral views.
9. *Heteroxenia pinnata* sp. nov.; tentacles, dorsal and ventral views.

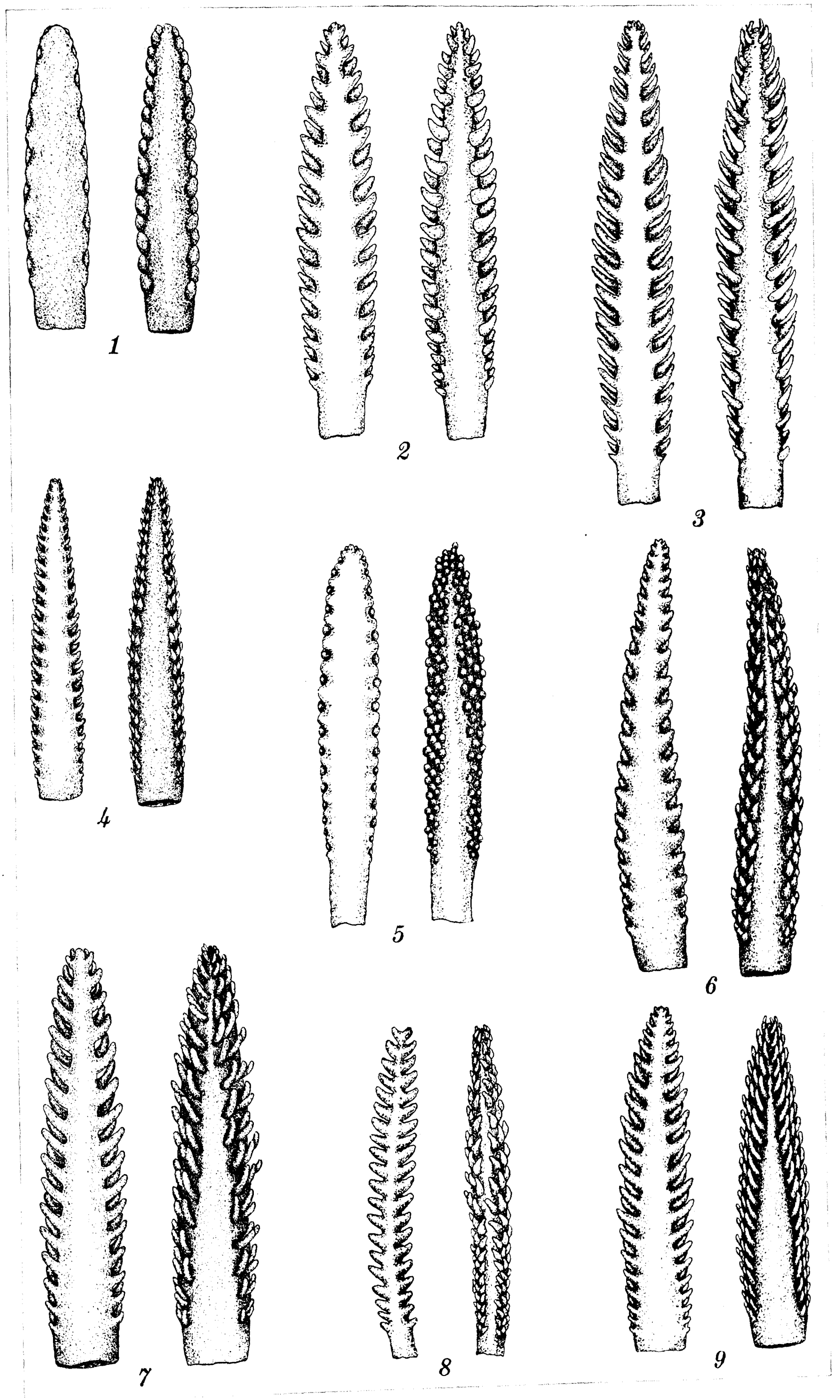


PLATE 1.

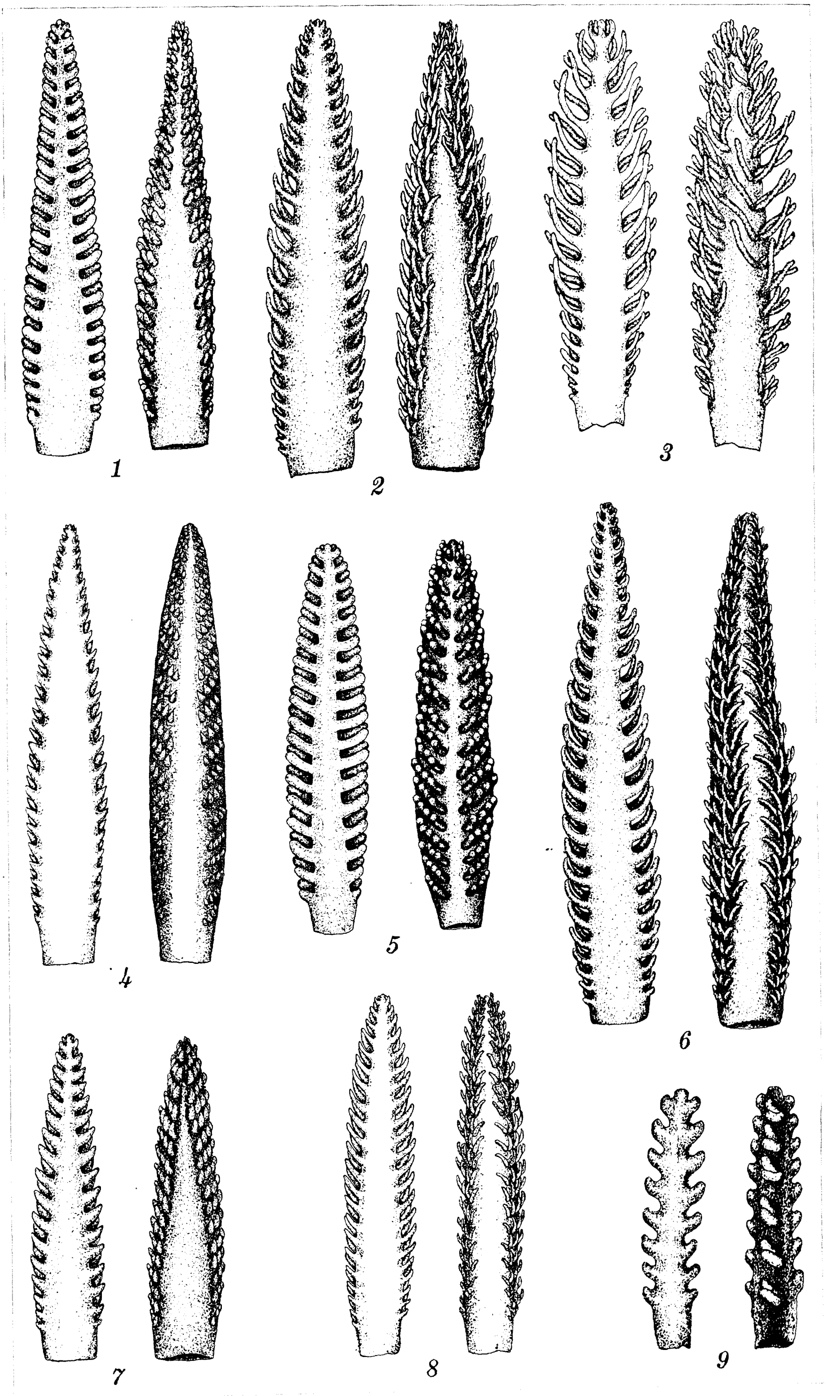


PLATE 2.

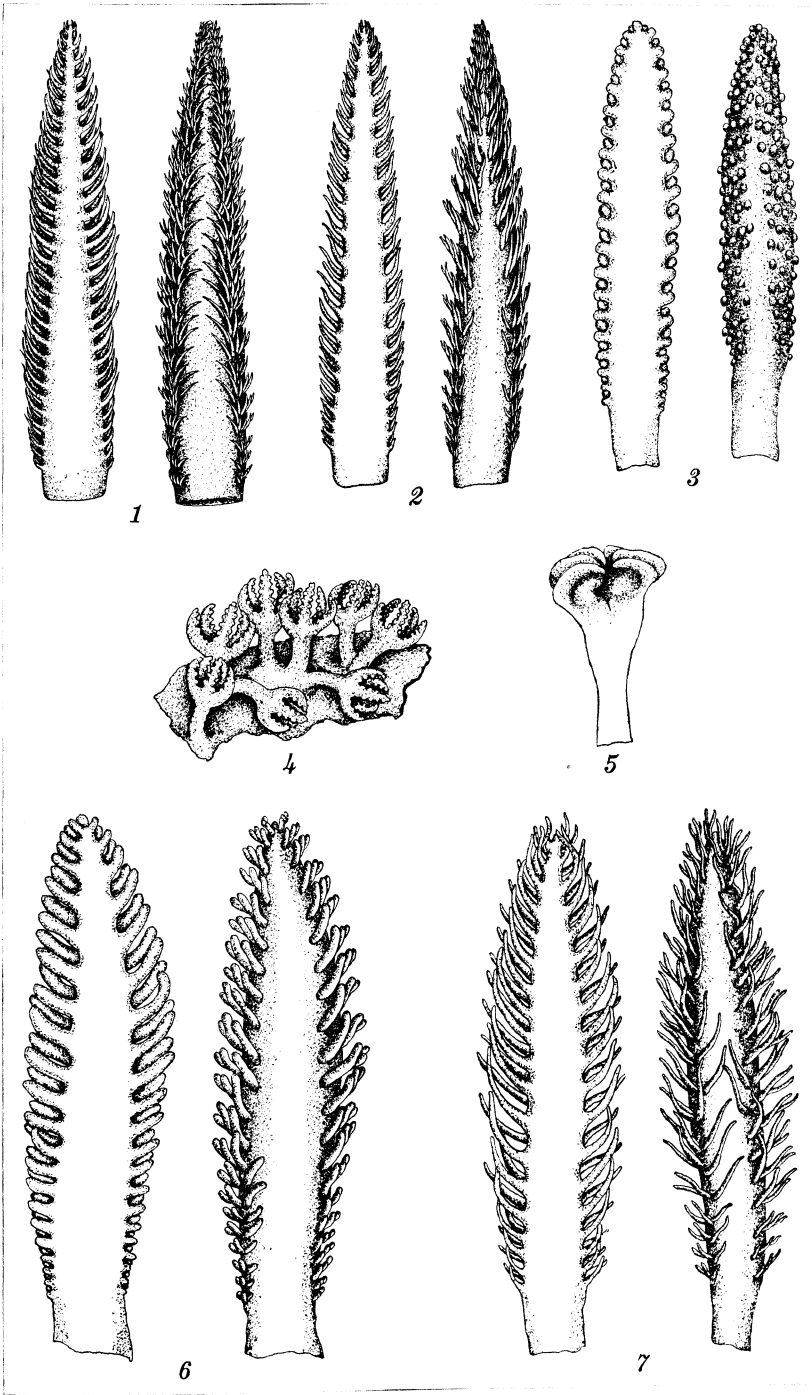
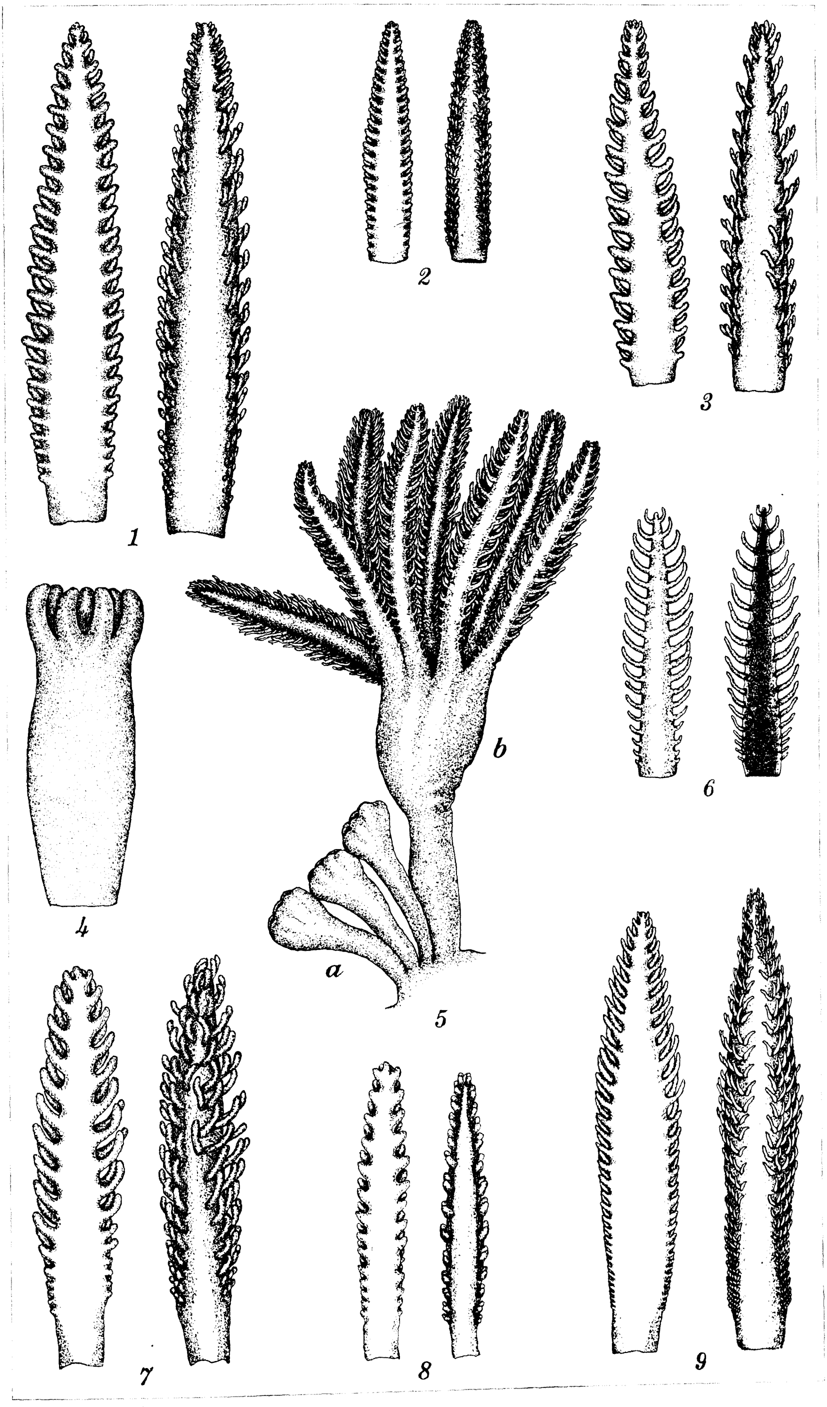


PLATE 3.



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THE PHILIPPINE JOURNAL OF SCIENCE

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MORE FRESH-WATER SPONGES FROM THE PHILIPPINES

By N. GIST GEE

Of Yenching University

Through the continued interest and kindness of Mr. R. C. McGregor, of the Bureau of Science, collections of fresh-water sponges, all made by Mr. A. C. Duyag at the following places on Luzon, Philippine Islands, have been submitted to me for examination, and I have found the species indicated below from the several localities.

1. March 17, 1932. Santa Agua, San Francisco del Monte, Rizal Province, *Spongilla fragilis* var. *decipiens*.
2. March 22, 1932. Morong, Rizal Province. "In a small river." *Spongilla fragilis* var. *decipiens* and *Ephydatia fortis* var. *vorstmani*.
3. March 23, 1932. Cardona, Rizal Province. "From the large lake, Laguna de Bay." *Spongilla fragilis* var. *decipiens*, *Spongilla fragilis*, and *Ephydatia fortis* var. *vorstmani*.
4. April 1 and 2, 1932. Lake Bunot, near San Pablo, Laguna Province. "A small crater lake." *Spongilla fragilis* var. *decipiens*.
5. April 3 and 4, 1932. Lake Calibato, near San Pablo, Laguna Province. *Spongilla fragilis* var. *decipiens* and *Ephydatia fortis* var. *vorstmani*.
6. April 5, 1932. Lake Pandin, near San Pablo, Laguna Province. *Spongilla fragilis* var. *decipiens* and *Trochospongilla latouchiana*.
7. April 6, 1932. Lake Yambo, near San Pablo, Laguna Province. *Spongilla fragilis* var. *decipiens* and a very tiny bit of *Ephydatia crateriformis*.
8. April 7 and 8, 1932. Lake Muekup, near San Pablo, Laguna Province. "Another of the crater lakes." *Spongilla fragilis* var. *decipiens*, *Ephydatia fortis* var. *vorstmani*, *Dosilia plumosa*, and *Trochospongilla latouchiana*.

9. May 12, 1932. Kamalibaguan, San Antonio, Zambales Province. "From a small swift river, with clear water." *Spongilla microsclerifera.*

The above record contains a total of six species, all already known from the Islands, collected from nine new localities.

SPONGILLA FRAGILIS var. DECIPIENS Weber.

Spongilla fragilis var. *decipiens* was found in eight of the nine localities, but was not collected in the ninth locality where the other *Spongilla, S. microsclerifera,* was taken.

This species is very variable, in a part of the specimens the gemmules form only small isolated patches closely attached to the support and arranged in a single layer. In some of the others, the gemmules continuously cover very much larger areas and are arranged in layers covering almost all of the supporting stems. Frequently the sponge forms a thicker cushion of growth than usual and the gemmules are arranged in a layer on the support and are also grouped together throughout the sponge body in twos, threes, or larger numbers in a manner very similar to the general grouping of the gemmules in the cosmopolitan form, *Spongilla fragilis.*

As a rule these sponges grow on the small dead branches of trees that have fallen into the water, and they vary in color from light yellowish brown to almost black. Their color seems to be dependent, to a certain degree at least, upon the amount of sediment in the water; some of the specimens contain the extremes of color on the same support, in which case they are evidently growths that have taken place at different times when the water bore a different quantity or type of sediment.

The Lake Pandin specimens have a large number of gemmule spicules with bulbous enlargements near the center.

The specimens from Lake Bunot are all small flat specimens taken from some flat support, probably stones, and in many cases the basal membranes are still intact. Most of these specimens are without gemmules, but a few of them have gemmules, bound together in groups as in *Spongilla fragilis,* scattered through the thin sponge. Had this sponge been found elsewhere and isolated from the other specimens it would probably have been called the type species rather than a variety, but the gemmule spicules are practically the same as those of the variety and one is inclined to call all the sponges by the same name. This very variable sponge seems to exhibit here in the Philippine Islands its transition from the type to the varietal form and raises the question as to whether the entire

lot of them are not, after all, *Spongilla fragilis* and should not be considered as variable forms of the type species. The layer of gemmules bound together as it is may be a necessary adaptation due to the thinness of the sponge, for when a thicker sponge body is present both arrangements of the gemmules may be found in the same specimen.

SPONGILLA MICROSCLERIFERA Annandale.

The small collection made from the small swift river with clear water at Kamalibaguan, San Antonio, consists of only one species, *Spongilla microsclerifera,* which was growing on branches of trees and forming continuous cushions, sometimes not more than a few millimeters thick, but at other times 1.5 centimeters thick.

The skeletal structure of the several specimens differs somewhat, sometimes in the thinner specimens it is made up of a meshwork without any distinct spicule fiber rays of any great length, but in the thicker specimens these perpendicular rays are clearly distinguishable and they are bound together by short, irregular, transverse but discontinuous rays.

When clean, the sponge is almost white; in some places it is covered with a green algal growth.

The gemmules grow in patches at the base of the sponge and are attached to the support. They seem to form small patches, at times almost a centimeter in length and irregular in shape. The gemmules are piled upon one another and are found four or five thick, but occur singly and have no characteristic grouping.

The gemmule spicules are very thickly spined in the portion around their ends, the spines are heavy and conical with sharp points, and often those perpendicular ones right near the ends of the spicules are recurved a bit at their tips. The spines near the middle of the spicule are smaller and fewer. The spicules are curved, rarely straight, and terminate in one or more finer spines; there may sometimes be several around the tip.

The flesh spicules are curved and very thin and are often even longer than the gemmule spicules. They are covered throughout their length with very fine spines, which are sometimes slightly larger in the middle of the spicule than at the end. In some of the spicules the longer spines may be divided or have other smaller spines on them near their ends.

This species was found in only one locality and it was the only sponge discovered there.

EPHYDATIA CRATERIFORMIS Potts.

Ephydatia crateriformis was represented in the collection by cnly a very minute scrap, which was accidentally found attached to the larger quantities of *Spongilla fragilis* var. *decipiens* collected in Lake Yambo, San Pablo. The specimen was a typical one in every way.

EPHYDATIA FORTIS var. VORSTMANI Gee.

Ephydatia fortis var. *vorstmani* was found in the following four localities: Morong, Rizal Province; Cardona, Laguna de Bay, Rizal Province; Lake Calibato, San Pablo, Laguna Province; and Lake Muekup, San Pablo, Laguna Province. These sponges are light in color and bear numerous gemmules. While there are variations in the size and the spininess of the skeleton spicules and similar variations in the birotulates, yet these specimens are all placed with this variety. This variety is quite a variable one.

TROCHOSPONGILLA LATOUCHIANA Annandale.

Trochospongilla latouchiana was found in only two places; namely, Lake Pandin and Lake Muekup, near San Pablo. In each case there were only three or four very small specimens growing on the tips of twigs with the whole of the rest of the twigs covered with the variety common in the collections, *Spongilla fragilis* var. *decipiens*. The sponge is very similar to those of this species already described from the Islands.

DOSILIA PLUMOSA Carter.

Dosilia plumosa was represented by one small characteristic specimen taken from Lake Muekup, one of the crater lakes near San Pablo. This lake is rich in sponges, producing four of the six forms represented in the whole collection.

NOTES ON ACANTHOCEPHALA IN THE PHILIPPINES

By MARCOS A. TUBANGUI

Of the Division of Biology and Serum Laboratory
Bureau of Science, Manila

SIX PLATES

INTRODUCTION

There have been recorded from the Philippines only two species of Acanthocephala; namely, the giant thorn-headed worm of swine, *Macracanthorhynchus hirudinaceus* (Pallas, 1781), by Schwartz (1925), and the beaded thorny-headed worm of rats, *Moniliformis moniliformis* (Bremser, 1811), by Tubangui (1931). In this paper are described six different species of these worms, one of which is from a fish and the rest from birds. Some years ago I collected from the small intestine of a native dog in Los Baños, Laguna, Luzon, a single specimen of what was believed to be a species of *Oncicola*. The material, however, cannot now be located, for which reason its description is not included here.

I wish to express my appreciation to Messrs. S. Garcia and A. Duyag, who collected most of the parasites to be described.

TECHNIC

The method advocated by Joyeux and Baer (1929) for collecting and preserving tapeworms was found satisfactory for fixing Acanthocephala in an extended condition and with the proboscis everted. After cleaning the body surface of the worms with a soft brush, they were placed in clean tap water, in which they were allowed to remain until they were dead or moribund. Then they were preserved in 5 per cent formalin solution. For microscopic study, the parasites were cleared and mounted at the same time in Gater's fluid by transferring them directly from the formalin solution to a slide containing a suitable amount of the liquid. The medium was evolved by Gater (1929) for mounting mosquito larvæ and has the following formula: Distilled water, 10 per cent; picked gum arabic, 8 per cent; chloral hydrate, 74 per cent; glucose syrup, 5 per cent; glacial acetic acid, 3 per cent. In a warm dry environment it

evaporates fairly quickly under a cover glass, and it is only necessary to run some more of the fluid under the cover glass with a pipette from time to time until air spaces are no longer formed. When completely dry, the slide may be put away as a permanent preparation.

Gater's medium has also been employed with equally satisfactory results in the rapid preparation of small to moderately large trematodes for examination under the microscope. In order to bring out the reproductive organs more conspicuously, the worms may either be stained with hydrochloric-acid-carmine solution before they are mounted or the medium may be tinted by the addition of a small amount of the stain before the unstained parasites are mounted in it. I have slides of echinostomes prepared in both ways in which the stain has remained unfaded for more than six months.

CLASSIFICATION

The Acanthocephala, or proboscis roundworms, together with the class Nematoda, or true roundworms, constitute the phylum Nemathelminthes. Yorke and Maplestone (1926) separate the members of the two classes as follows:

"Class I. Nematoda Rudolphi, 1808, emend. Diesing, 1861. *Nemathelminthes;* with a gut, but without proboscis.

"Class II. Acanthocephala Rudolphi, 1808. *Nemathelminthes;* without a gut, but with a proboscis usually protrusible and almost invariably furnished with hooks."

There is a general agreement among various authors in dividing the Acanthocephala into three groups, which, following the classification proposed by Southwell and Macfie (1925) as modified by Faust (1929), may be distinguished as follows:

1. Prostatic glands a single syncytial mass.... Order NEOECHINORHYNCHATA.
   Prostatic glands not a single syncytial mass.. 2.
2. Proboscis reduced, not capable of being withdrawn into the proboscis sheath .... Order GIGANTORHYNCHATA.
   Proboscis well developed and capable of being withdrawn into the proboscis sheath .... Order ECHINORHYNCHATA.

DESCRIPTIONS

Order NEOECHINORHYNCHATA

Family NEOECHINORHYNCHIDÆ Van Cleave, 1919

NEOECHINORHYNCHUS OCTONUCLEATUS sp. nov. Plate 1, figs. 1 and 2.

Material.—A single, nearly mature female from the small intestine of a fresh-water fish.

In the shape of the proboscis and in the number of its hooks, the specimen agrees with the members of the genus *Neoechinorhynchus* Stiles and Hassall, 1905. It differs from them, however, in the number of its subcuticular giant nuclei, of which there are six in the mid-dorsal line and two in the mid-ventral line. This difference is significant for, according to Van Cleave (1919), the members of *Neoechinorhynchus* and those of the other genera in the family Neoechinorhynchidæ normally possess only five subcuticular nuclei in the mid-dorsal and one in the mid-ventral line. For this reason it will be necessary to modify the definition of the family and perhaps even to propose a distinct genus for the parasite in question.

Description.—Male unknown. Female 9.09 by 1.09 millimeters in size. Body cylindrical, anterior end a trifle broader than posterior end which tapers at first gradually, then abruptly, into a knoblike process. Cuticle smooth, thick; subcuticle with six giant nuclei in mid-dorsal line, two more in mid-ventral line.

Proboscis retracted and cannot be measured accurately; it appears short and globose; armed anteriorly with eighteen spines that are presumably arranged in three anteroposterior rows. Anterior row of hooks largest, 88 to 91 microns long, with distinct roots; rest of hooks smaller, those in last row only 35 to 38 microns long and without distinct roots.

Proboscis sheath with simple wall, 0.9 by 0.3 millimeter in size. Central nervous system not seen.

Lemnisci about twice as long as proboscis sheath, one with a single large nucleus and the other with two nuclei.

Body cavity filled with numerous roundish structures probably representing very immature ova. Genital pore ventral near posterior end of body.

Specific diagnosis.—*Neoechinorhynchus:* Female 9.09 by 1.09 millimeters in size. Subcuticle in mid-dorsal line with six and in mid-ventral line with two giant nuclei. Proboscis armed anteriorly with three circles of six hooks each; anterior row of hooks 88 to 91 microns long, those in last row 35 to 38 microns long. Proboscis sheath with simple wall, 0.9 by 0.3 millimeter in size. Lemnisci about twice as long as proboscis sheath.

Host.—Fresh-water fish, "ayuñgin" (? *Therapon argenteus*).

Location.—Small intestine.

Locality.—Los Baños, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection No. 112.

Order ECHINORHYNCHATA

Family ECHINORHYNCHIDÆ Cobbold, 1879

ECHINORHYNCHUS CENTROPUSI sp. nov. Plate 1, figs. 3 and 4; Plate 2, figs. 1 to 4.

Material.—Four males and five females all mature, from the small intestine of the red-winged coucal, *Centropus viridis;* also two apparently mature females supposed to have been collected from the rough-crested cuckoo, *Dasylophus superciliosus.* The latter host, however, must have been mistaken for a *Centropus,* for in an attempt to verify the origin of the second lot of material, we have examined several other cuckoos with negative results. On the other hand, the parasite seems common in the coucal.

Compared with *Echinorhynchus bulbocaudatus* Southwell and Macfie, 1925, a parasite of *Centropus phasiani* in Australia, the Philippine species is characterized by its smaller size and by the number and arrangement of the hooks on the proboscis.

Description.—Body elongate, cylindrical, with surface slightly rugose; anterior sixth or seventh of body length, especially in female, more or less enlarged and separated from rest of body by a circular constriction. Male measures 11.5 to 14.5 by 0.80 to 1 millimeters, female 20 to 30 by 0.90 to 1.25 millimeters.

Proboscis subspherical to ovate, 0.40 to 0.50 by 0.40 to 0.46 millimeter in size, armed with sixteen to eighteen circles of eight to ten hooks each. Hooks on anterior third of proboscis larger, each with rectangular root slightly hollowed posteriorly; they measure 87 to 102 microns long, including roots; rest of hooks smaller, 38 to 42 microns long, and with much-reduced roots.

Neck very short, unarmed.

Proboscis sheath double-walled, 1 to 1.20 by 0.30 to 0.38 millimeters in size, that of female only a trifle larger. Central nervous system behind middle of length of proboscis sheath.

Lemnisci narrow to moderately broad, each with single large nucleus, about twice as long as proboscis sheath, and reach posteriorly in male to anterior border of first testis.

Male: Testes oval to elongate, one immediately behind the other, sometimes slightly overlapping, 0.90 to 1.04 by 0.50 to 0.52 millimeters in size; they are located in anterior region of body, 0.30 to 1 millimeter from posterior end of proboscis sheath and immediately in front of circular constriction separating anterior sixth or seventh of body length from rest of body. Prostatic glands long, but their number could not be ascertained. Cement reservoir elongate, 2.40 by 0.30 millime-

ters in size. Bursa evaginated in two male specimens, bell-shaped, 1 to 1.12 by 0.85 to 0.94 millimeters in size.

Female: Posterior end slightly swollen before terminating in a conical tip. Uterine bell relatively small. Eggs in body cavity small, numerous, each with three concentric membranes, 29.0 to 37.5 by 14.5 to 18.7 microns in size.

Specific diagnosis.—*Echinorhynchus:* Male 11.5 to 14.5 by 0.80 to 1 millimeters in size, female 20 to 30 by 0.90 to 1.25 millimeters. Proboscis subspherical to ovate, 0.40 to 0.50 by 0.40 to 0.46 millimeter in size, armed with sixteen to eighteen circles of eight to ten hooks each; larger hooks 87 to 102 microns long, with rectangular roots; smaller hooks 38 to 42 microns long, with much-reduced roots. Proboscis sheath 1 to 1.20 by 0.30 to 0.38 millimeters in size. Central nervous system behind equator of proboscis sheath. Lemnisci about twice as long as proboscis sheath, reach posteriorly in male to anterior testis. Testes 0.90 to 1.04 by 0.50 to 0.52 millimeters in size. Eggs 29.0 to 37.5 by 14.5 to 18.7 microns in size.

Hosts.—*Centropus viridis* (type host) and *Dasylophus superciliosus* (?).

Location.—Small intestine.

Localities.—Novaliches, Rizal (type locality), and Los Baños, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection No. 119.

PROSTHORHYNCHUS LIMNOBÆNI sp. nov. Plate 5, figs. 1 to 3.

Material.—Two apparently mature, poorly preserved males from the intestine of *Limnobænus fuscus.*

The specimens agree with the description of the genus *Prosthorhynchus* Kostylew, 1915, as given by Travassos (1926) in the following characters: The elongate, cylindrical, and ventrally inclined proboscis; the length of the lemnisci, which is only slightly more than that of the proboscis sheath; and the shape and position of the testes. Travassos does not describe the proboscis sheath, but according to Van Cleave (1923) it is double-walled. In the specimens in question it appears to possess a simple wall.

Description.—Female unknown. Male cylindrical, with smooth surface, 18 to 20 millimeters in length by 1.15 to 1.20 millimeters in maximum diameter; anterior end truncate, slightly bent; posterior end rounded, the bursa arising from its ventral aspect.

Proboscis elongate, cylindrical, measuring 1 to 1.06 by 0.18 to 0.20 millimeters and armed with numerous hooks arranged in forty-three alternating anteroposterior rows of eight hooks each. Hooks from one end of proboscis to the other almost uniform in size, with well-developed rectangular roots; lamina of hooks 50 to 54 microns, roots 45.6 to 48 microns long.

Neck absent.

Proboscis sheath elongate, slightly dilated posteriorly, with simple wall, 2.50 to 2.60 by 0.37 to 0.45 millimeters in size. Central nervous system between anterior and middle thirds of length of proboscis sheath.

Lemnisci narrow, slightly coiled, only a little longer than proboscis sheath.

Testes behind middle of body length, measure 0.86 to 1.35 by 0.48 to 0.54 millimeters. Details of prostatic glands could not be determined due to poor state of preservation of specimens. Cement reservoir elongate, 1.90 by 0.32 millimeters in size. Evaginated bursa measures 0.45 by 1 millimeter.

Specific diagnosis.—Prosthorhynchus: Female unknown. Male 18 to 20 by 1.15 to 1.20 millimeters in size. Proboscis 1 to 1.06 by 0.18 to 0.20 millimeters, armed with forty-three alternating anteroposterior rows of eight hooks each. Hooks almost uniform in size, with well-developed rectangular roots; lamina of hooks 50 to 54, roots 45.6 to 48 microns long. Neck absent. Proboscis sheath 2.50 to 2.60 by 0.37 to 0.45 millimeters; lemnisci only slightly longer than proboscis sheath. Testes behind middle of body length, 0.86 to 1.35 by 0.48 to 0.54 millimeters.

Host.—Limnobænus fuscus.

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection No. 122.

Family CENTRORHYNCHIDÆ Van Cleave, 1916

CENTRORHYNCHUS INSULARIS sp. nov. Plate 3, figs. 1 to 5.

Material.—Numerous mature males and females from the intestines of three different kinds of birds of prey.

Compared with the forms listed by Travassos (1926) in the genus *Centrorhynchus* Luehe, 1911, this species appears to resemble more closely *C. asturinus*, a parasite of several kinds of hawks in Australia. It seems to differ from the latter, as described by Johnston (1913) and by Southwell and Macfie, only in the number and arrangement of the hooks on the proboscis.

Description.—Body elongate, slightly curved, swollen anteriorly in both sexes; surface smooth.

Male smaller than female, 15 to 22 millimeters long, its swollen portion 1.3 to 1.8 millimeters in diameter and constituting about one-third of total body length; posterior region rounded distally, 0.6 to 1.1 millimeters across.

Proboscis ovoid, 0.60 to 0.64 by 0.32 to 0.34 millimeter in size, covered with numerous hooks arranged in thirty-two to thirty-four anteroposterior rows of sixteen to eighteen hooks each. Hooks with quadrangular roots and almost uniform in size; except those in last row, which are smaller and similar to those on neck; they measure 70 to 75 microns long, including roots.

Neck sharply delimited from proboscis by circular constriction, about as long as proboscis and armed with nineteen to twenty anteroposterior rows of hooks, each row with sixteen to twenty hooks. Hooks with very much reduced roots, 36 to 44 microns long.

Proboscis sheath double-walled, elongate, 1.60 to 1.70 by 0.37 to 0.43 millimeters in size. Ribbonlike retractor muscles attached at distal end of sheath; central nervous system near middle of its length. Retinacula long, narrow.

Lemnisci about twice as long as proboscis sheath, extending posteriorly to middle of distance between posterior end of proboscis sheath and anterior border of first testis; in contracted specimens, however, they may reach the anterior border of latter organ. Each seems to be provided with a prominent nucleus.

Testes oval to elongate, one very slightly obliquely behind the other and somewhat overlapping; they are located in middle of swollen anterior body region and measure 0.95 to 1.20 by 0.46 to 0.52 millimeters. Prostatic glands closely bunched together, 10 to 11.5 millimeters long; cement reservoir roomy, 1.80 to 2.50 by 0.43 to 0.65 millimeters in size; bursa in the retracted position 1.5 to 2 millimeters long.

Female 33 to 40 millimeters long, its swollen anterior region 1.60 to 2.25 millimeters in diameter and constituting one-fifth to one-fourth of total body length; posterior region of body 0.95 to 1.35 millimeters in diameter, produced distally behind genital pore into a short, blunt process. Proboscis 0.60 to 0.80 by 0.32 to 0.36 millimeter in size. Neck 0.40 to 0.50 millimeter long, separated from proboscis by constriction. Hooks on proboscis and neck of about the same size, number, and arrangement as those of male. Proboscis sheath 1.70 to 2.10 by 0.40 to 0.46 millimeters in size. Mature eggs numerous in body cavity, oval,

with three concentric membranes and a central nucleuslike mass; they measure 52.4 to 55 by 22.8 to 25 microns. (In one lot of specimens from *Spilornis bacha,* the mature eggs measure 45.7 to 50 by 22.8 to 25 microns.)

Specific diagnosis.—Centrorhynchus: Body elongate, slightly curved, with smooth surface, swollen anteriorly; male 15 to 22, female 33 to 40 millimeters long. Proboscis ovoid, 0.60 to 0.64 by 0.32 to 0.34 millimeter in male, 0.60 to 0.80 by 0.32 to 0.36 millimeter in female, armed with thirty-two to thirty-four anteroposterior rows of sixteen to eighteen hooks each. Neck separated from proboscis by circular constriction, about as long as or slightly shorter than proboscis, armed with nineteen to twenty anteroposterior rows of sixteen to twenty hooks each. Proboscis sheath 1.60 to 1.70 by 0.37 to 0.43 millimeters in size in male, 1.70 to 2.10 by 0.40 to 0.46 millimeters in female. Lemnisci about twice as long as proboscis sheath. Testes in middle of swollen body region of male, 0.95 to 1.20 by 0.46 to 0.52 millimeters in size. Mature eggs oval, with three concentric membranes, 45.7 to 55 by 22.8 to 25 microns in size.

Hosts.—Haliastur intermedius (type host), *Butastur indicus,* and *Spilornis bacha.*

Location.—Intestine.

Localities.—Iriga, Camarines Sur (type locality); Novaliches, Rizal, Luzon; and Palo, Leyte.

Type specimens.—Philippine Bureau of Science parasitological collection No. 113; paratypes Nos. 126 and 137.

EMPODIUS TURNIXENA sp. nov. Plate 4, figs. 1 to 4.

Material.—Three females from the intestine of *Turnix ocellata.*

The specimens are placed tentatively in the genus *Empodius* Travassos, 1916. Travassos (1924), who refers this genus to the family Gigantorhynchidæ, describes the hooks on the proboscis as being arranged into transverse and longitudinal series. This arrangement of the hooks was not observed in the specimens in question, but in other characters they tally with the description of the genus as given by Southwell and Macfie and included by them in the family Centrorhynchidæ.

Description.—Male unknown. Female elongate, cylindrical, more or less distinctly annulated superficially except at most anterior end; posterior extremity rounded, the cuticle sur-

rounding the genital pore being usually wrinkled or folded. Total length 12.5 to 17.5 millimeters, maximum diameter 0.62 to 0.70 millimeter. In opaque specimens the arrangement of the excretory vessels shows distinctly through the cuticle.

Proboscis somewhat conical, 0.34 to 0.38 by 0.22 to 0.26 (at base) millimeter in size, armed with thirteen to fourteen anteroposterior rows of eight to ten hooks each. Hooks bent, 55 to 65 microns long; they arise from indistinct papillalike, circular roots.

Neck as long as proboscis or shorter, 0.30 to 0.34 millimeter in maximum diameter, armed with about the same number of anteroposterior rows of hooks as the proboscis, each row containing twelve to fourteen hooks. Hooks on anterior half of neck larger, being one-third to one-half the size of those on proboscis; those on posterior half very minute.

Proboscis sheath double-walled, relatively small, measuring 0.50 to 0.65 by 0.20 to 0.24 millimeter. Central nervous system at equator of proboscis sheath or slightly posterior to that level.

Lemnisci much elongated but narrow, 3.80 to 4.05 millimeters long.

Body cavity filled with numerous immature eggs, 41.5 to 45.5 by 20.8 to 22.5 microns in size. Uterine bell measures 0.50 by 0.14 millimeter. Genital pore posteroterminal.

Specific diagnosis.—Empodius: Male unknown. Female 12.5 to 17.5 by 0.62 to 0.70 millimeters in size; body surface distinctly annulated. Proboscis 0.34 to 0.38 by 0.22 to 0.26 millimeter, armed with thirteen to fourteen anteroposterior rows of eight to ten hooks each, 55 to 65 microns long. Neck about as long as or shorter than proboscis and armed with about the same number of anteroposterior rows of hooks, each row with twelve to fourteen small hooks. Proboscis sheath 0.50 to 0.65 by 0.20 to 0.24 millimeter in size. Lemnisci narrow, 3.80 to 4.05 millimeters long. Eggs (immature) 41.5 to 45.5 by 20.8 to 22.5 microns in size.

Host.—Turnix ocellata.

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection No. 139.

Order GIGANTORHYNCHATA

Family GIGANTORHYNCHIDÆ Hamann, 1892

OLIGACANTHORHYNCHUS POMATOSTOMI (Johnston and Cleland, 1911). Plate 6, figs. 1 to 4.

Echinorhynchus pomatostomi JOHNSTON and CLELAND, 1911.

Material.—Numerous immature males and females found encysted in the subcutaneous tissues of the necks of two species of birds.

The specimens bear a very close resemblance to those described by Johnston and Cleland (1911) from the subcutaneous tissues of Australian birds, differing from them only in being slightly larger and in the greater length of their lemnisci. It should be borne in mind, however, that both the Philippine and Australian forms are in the immature stage, and it is possible that the differences noted are due to differences in age. In fact, according to Southwell and Macfie (1925), the length of the lemnisci even in mature worms may vary within wide limits.

It has been decided to refer the parasite to the genus *Oligacanthorhynchus* Travassos, 1915, because of the absence of a well-marked sexual dimorphism, the shape and armature of the proboscis, the shape and length of the lemnisci, the location and shape of the testes, and the shape, number, and arrangement of the prostatic glands.

Description.—The cysts, as described by Johnston and Cleland, have the appearance of grains of rice or small maggots.

Sexual dimorphism not marked. Total length of body of extended individuals 6 to 7.50 millimeters, maximum diameter 1.08 to 1.40 millimeters.

Proboscis subspherical, 0.50 to 0.56 millimeter across, armed with five to six (usually five) anteroposterior rows of eight hooks each. Hooks of first four rows larger, not unlike those of members of the tapeworm genus *Tænia* in appearance, measuring 170 to 185 microns long; last row of hooks smaller, with vestigeal roots, and measure 80 to 90 microns long. Pointed extremity of hooks curved, sometimes provided with small inner barb.

Proboscis sheath cylindrical, with simple wall, 1.00 to 1.10 by 0.40 to 0.50 millimeters in size. Central nervous system at or slightly behind middle of length of proboscis sheath.

Lemnisci narrow, coiled, as long as or sometimes longer than body proper; they do not, however, extend to posterior end of body, but only to middle of its length or a little behind that level.

Male: Reproductive organs in posterior two-thirds of body length. Testes relatively small, oval, tandem, 0.40 to 0.48 by 0.20 to 0.24 millimeter in size, located in middle third of body length. Prostatic glands oval, four pairs, arranged end to end from second testis to cement reservoir; latter 0.56 to 0.80 by 0.24 to 0.28 millimeter in size. Bursa retracted in all specimens examined; measures 0.90 to 1.10 by 0.32 to 0.36 millimeters.

Female: In all of the many specimens examined the ovary has disappeared. Instead numerous roundish bodies, 80 to 200 microns in diameter, occur in the body cavity either singly or in groups of two or four; these are most probably young ova, the remnants of the ovary. Uterine bell apparently not yet fully developed. Genital pore on ventral surface, near posterior end of body.

Hosts.—*Hypotænidia philippensis* and *Excalfactoria lineata.*

Location.—Subcutaneous tissues of neck.

Locality.—Novaliches, Rizal, Luzon.

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ILLUSTRATIONS

[Abbreviations used: *b*, bursa; *cns*, central nervous system; *cr*, cement reservoir; *ev*, excretory vessels; *gn*, giant nucleus; *gp*, genital pore; *l*, lemniscus (i); *n*, neck; *o*, eggs; *pg*, prostatic glands; *pr*, proboscis; *prs*, proboscis sheath; *rt*, retinacula.]

PLATE 1

FIG. 1. *Neoechinorhynchus octonucleatus* sp. nov.; entire worm, lateral view.
2. Proboscis hooks of *Neoechinorhynchus octonucleatus; a*, large anterior hook; *b*, small posterior hook.
3. *Echinorhynchus centropusi* sp. nov.; anterior end of female, ventral view.
4. *Echinorhynchus centropusi* sp. nov.; egg.

PLATE 2

ECHINORHYNCHUS CENTROPUSI SP. NOV.

FIG. 1. Rows of proboscis hooks.
2. Anterior end of male, lateral view.
3. Posterior end of male, lateral view.
4. Posterior end of female, ventral view.

PLATE 3

CENTRORHYNCHUS INSULARIS SP. NOV.

FIG. 1. Hooks; *a*, on neck; *b*, on proboscis.
2. Anterior end of male, ventral view.
3. Posterior end of male, ventral view.
4. Posterior end of female, lateral view.
5. Egg.

PLATE 4

EMPODIUS TURNIXENA SP. NOV.

FIG. 1. Proboscis hooks.
2. Anterior end of female, lateral view.
3. Anterior end of female, lateral view, proboscis enlarged.
4. Posterior end of female, lateral view.

PLATE 5

PROSTHORHYNCHUS LIMNOBÆNI SP. NOV.

FIG. 1. Anterior end of male, lateral view.
2. Proboscis hooks.
3. Posterior end of male, lateral view.

PLATE 6

OLIGACANTHORHYNCHUS POMATOSTOMI (JOHNSTON AND CLELAND, 1911)

FIG. 1. Large anterior hooks from proboscis.
2. Small posterior hook from proboscis.
3. Male, entire worm, lateral view.
4. Female, entire worm, lateral view.

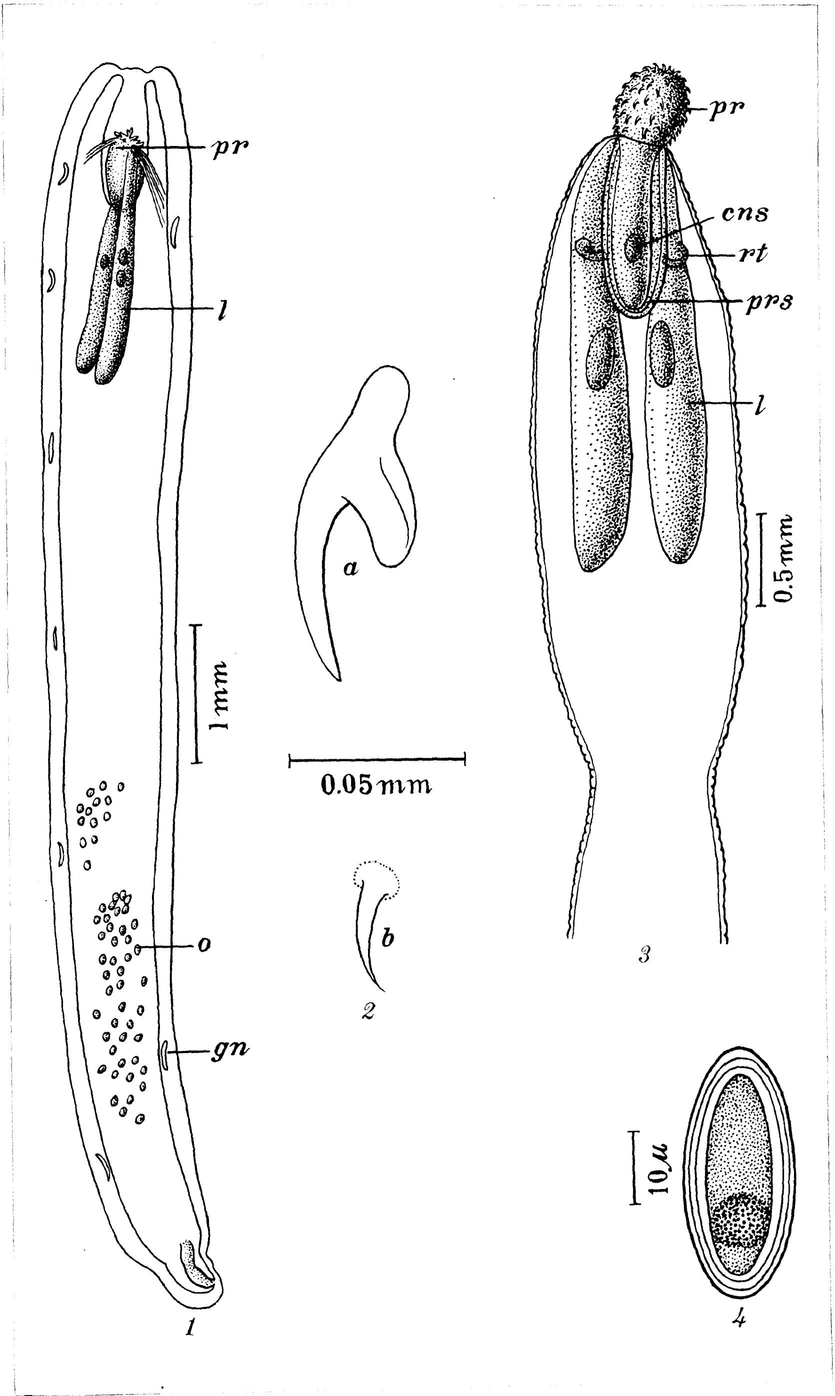
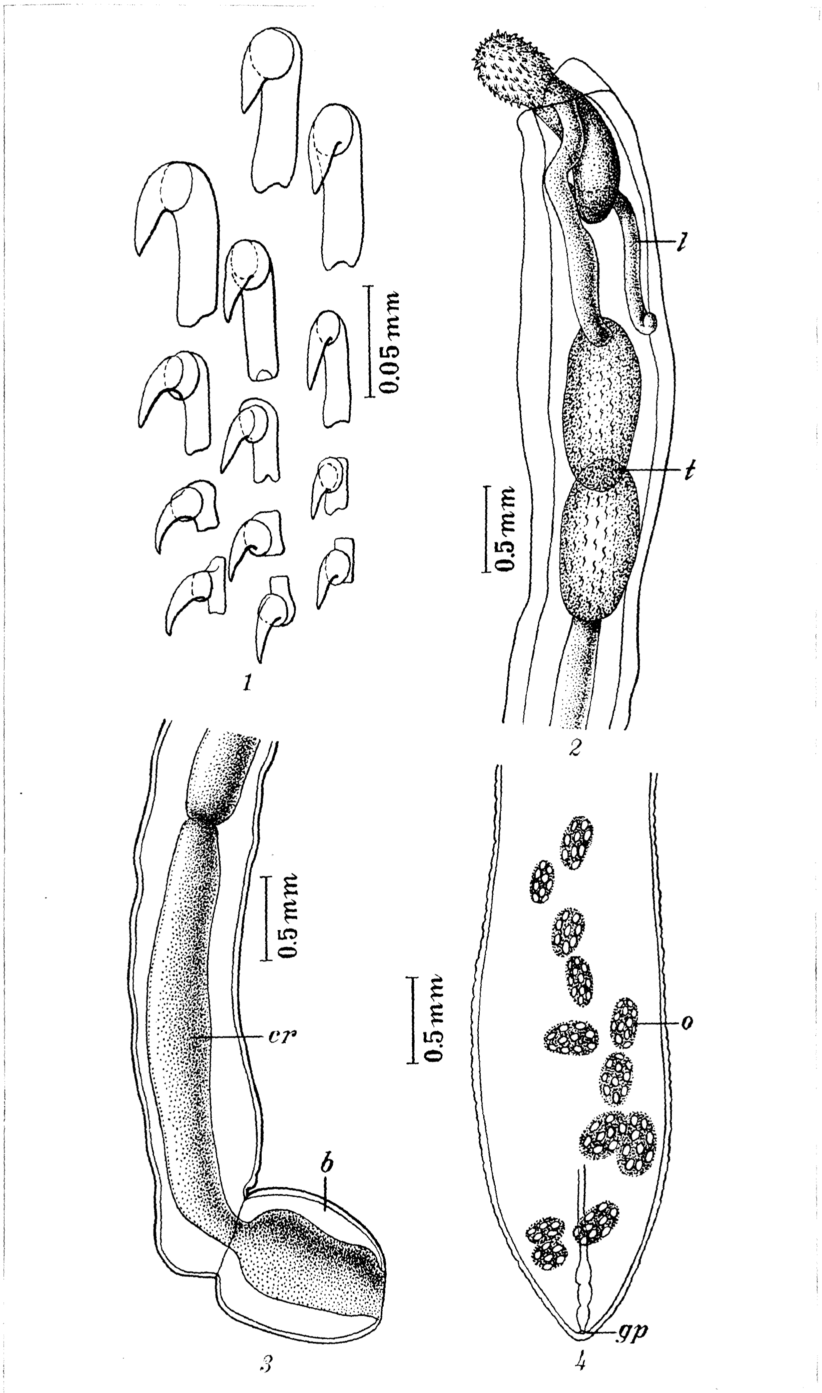


PLATE 1.



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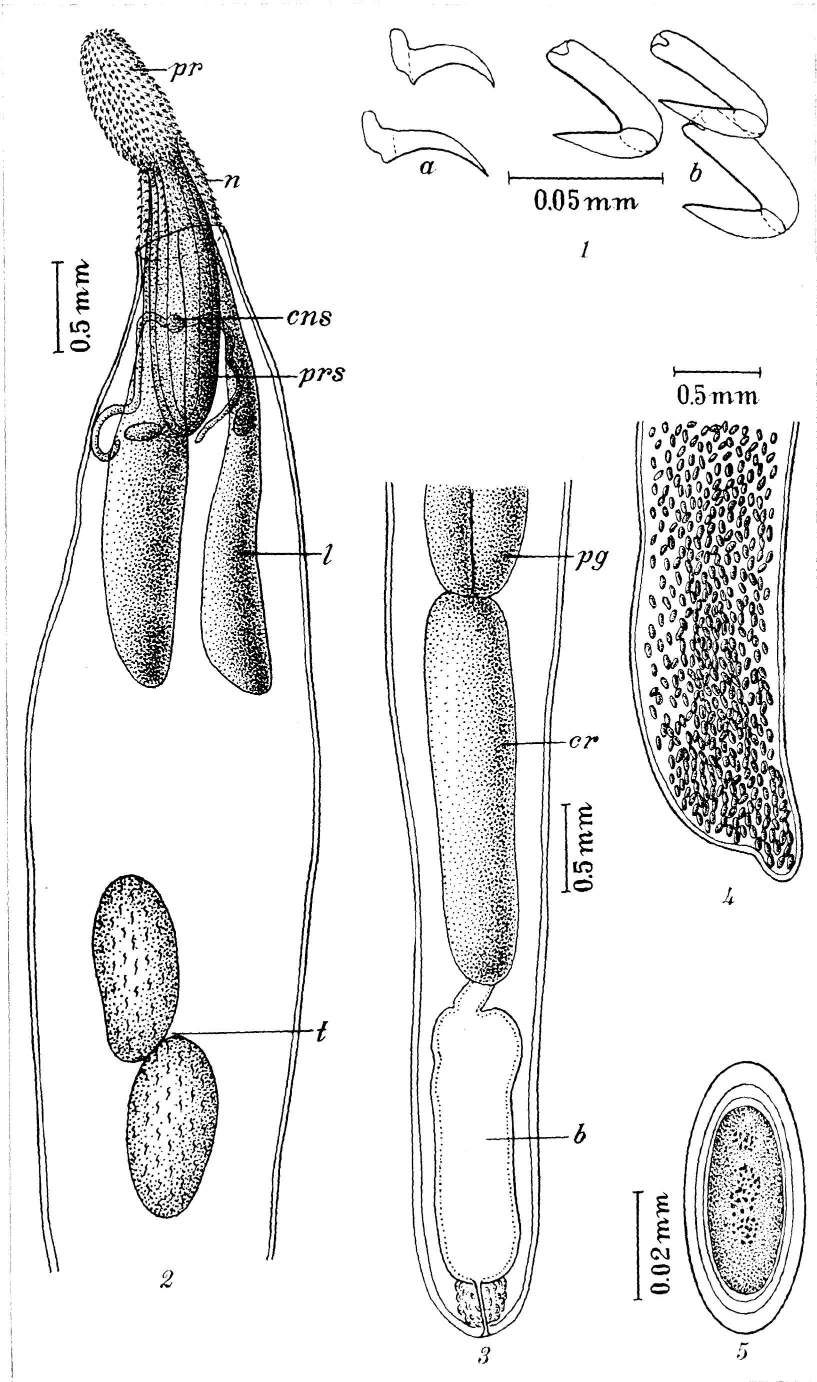

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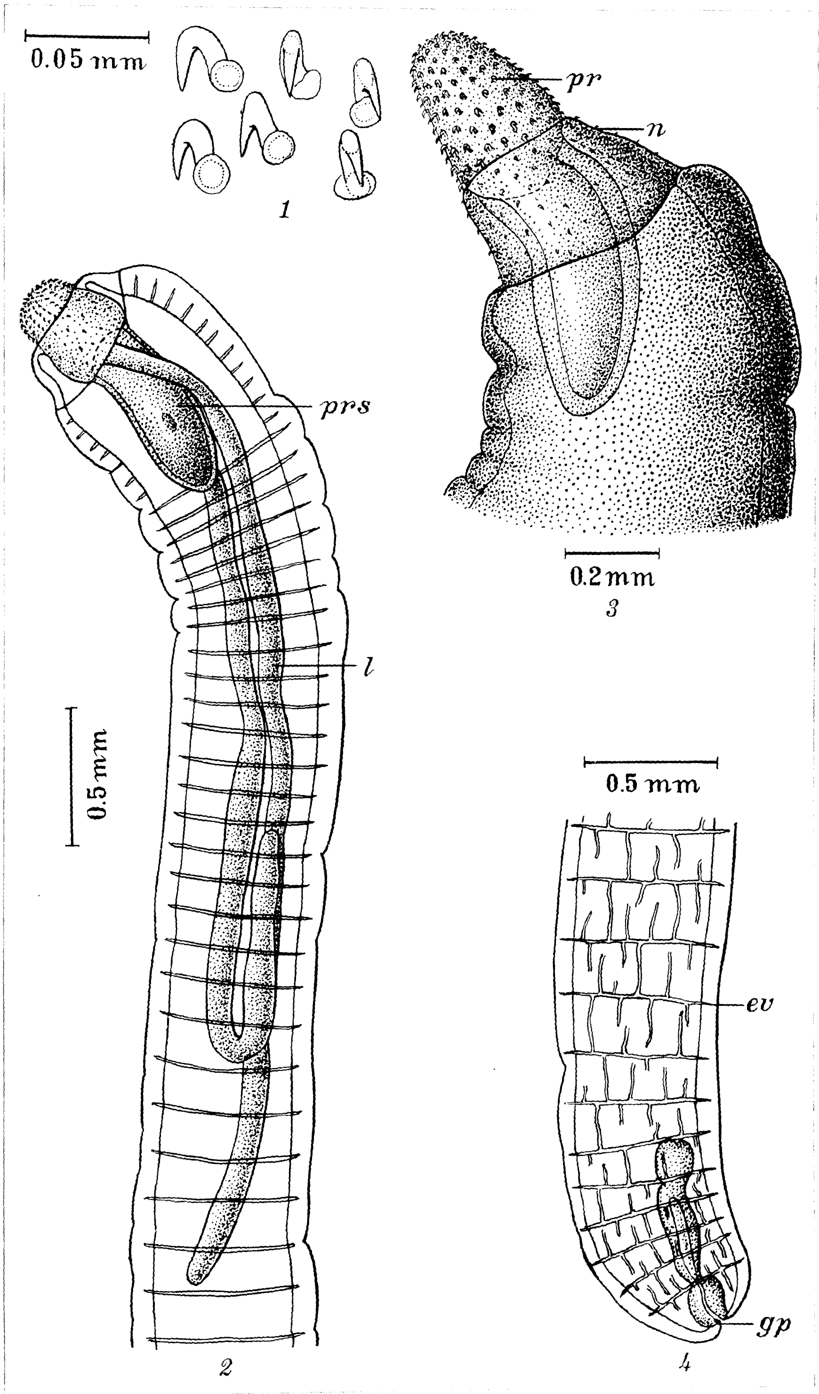

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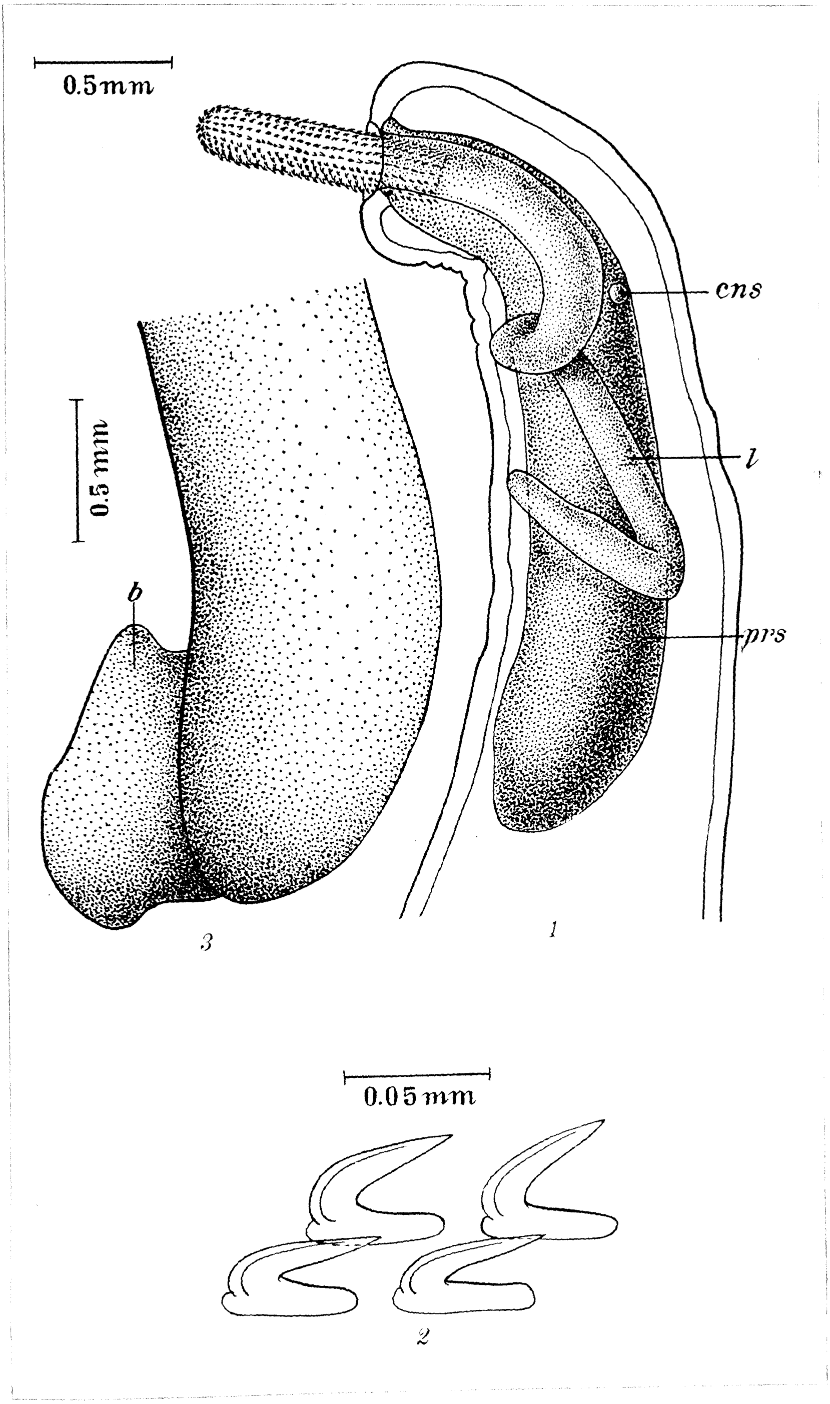


PLATE 5.

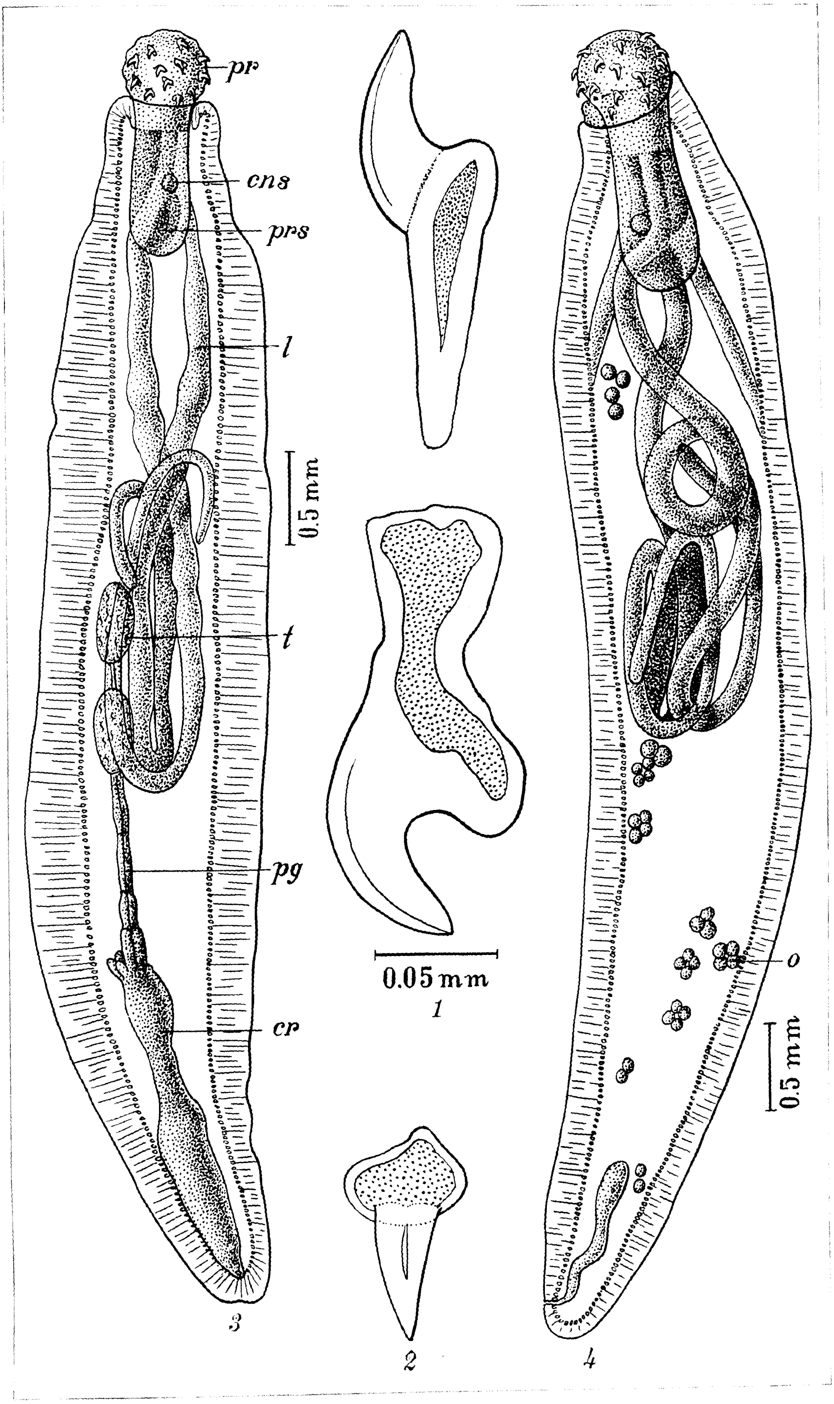


PLATE 6.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XII [1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

THREE PLATES

The crane flies discussed in the present report are chiefly from the mountains of western China, where they were taken by the Reverend Mr. Franck. A few additional records are based on the very extensive collections of Tipulidæ taken on the border between China and Tibet by the Reverend David C. Graham. The Japanese Tipulidæ discussed herewith were included in extensive series of these flies taken in the Japanese Alps by Dr. Jiro Machida, and in smaller collections made by Dr. Masaaki Tokunaga and by Mr. H. Yokouchi, the latter received through the kindly interest of Prof. Teiso Esaki. I am very greatly indebted to all of the entomologists above mentioned for this continued coöperation in making known the vast crane fly fauna of the mountains of eastern Asia. Except where noted to the contrary, the types of all novelties in this paper are preserved in the collection of the writer.

TRICHOCERIDÆ

I am including this family in the present series of papers on the eastern Asian crane flies.

TRICHOCERA RETICULATA sp. nov. Plate 1, fig. 1.

Belongs to the *maculipennis* group; general coloration dark; knobs of halteres blackened; femora yellowish brown, with a narrow black subterminal ring, the tips narrowly light yellow; wings yellow, with a heavy reticulate brown pattern.

Female.—Length, about 7.5 millimeters; wing, 7.8.

Rostrum and palpi black. Antennæ black throughout. Head blackish.

Mesonotum chiefly dark-colored, the præscutum with a yellowish pollen that leaves brown stripes on the disk. Pleura dark

[1] Contribution from the entomological laboratory, Massachusetts State College.

gray, variegated by blackish areas. Halteres pale yellow, the knobs blackened. Legs with the coxæ dark-colored, pruinose, the fore coxæ more yellowish beneath; femora yellowish brown, with a narrow black subterminal ring, the extreme tips light yellow; tibiæ brown, the bases and tips slightly darker; tarsi dark brown. Wings (Plate 1, fig. 1) light yellow, with a heavy, reticulate, dark brown pattern, including larger areas at origin of Rs, anterior cord and in outer radial field about opposite the end of vein R_{1+2}; narrow, transverse, brown lines in all cells of wing excepting the small 1st M_2 and 2d A; in cell C about fourteen such areas, in cell M about nine, in cell Cu about twelve; in the outer radial field the areas narrower and more widely separated; in cell 1st A the individual areas are irregularly doubled; veins obscure yellow, darker in the infuscated areas. Venation: Cell 2d A relatively wide.

Abdomen black, the caudal margins of the segments narrowly paler.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 11,000 feet, July 18, 1931 (*Franck*).

Trichocera reticulata is most nearly allied to the Oriental *T. ocellata* Walker and *T. punctipennis* Brunetti, differing from these and all other known members of the family in the closely reticulated, dark brown pattern of the light yellow wings, with no indication of the areas being arranged to form ocelliform patterns.

TIPULIDÆ

TIPULINÆ

TIPULINI

TIPULA NIGROBASALIS sp. nov.

Large (wing, female, over 25 millimeters); antennæ bicolorous; mesonotal præscutum with the ground color golden yellow, with four brown stripes that are narrowly bordered by slightly darker brown, the stripes confluent or nearly so; scutellum velvety black; postnotal mediotergite and central portion of pleura light golden yellow; propleura, dorsopleural region, and pleurotergite dark brown; halteres blackened; legs long, yellow, the femoral tips narrowly blackened; wings brownish yellow, the prearcular region conspicuously blackened; abdominal tergites reddish brown, the lateral margins darker brown.

Female.—Length, about 33 millimeters; wing, 27.5.

Frontal prolongation of head relatively long, brown, darker laterally; nasus unusually long and powerful; palpi black. Antennæ with the elongate scape dark brown; pedicel obscure yellow; flagellar segments bicolorous, yellow, with the basal enlargements dark brown; verticils exceeding the segments. Head brown, the posterior orbits narrowly obscure yellow; region of anterior vertex more velvety dark brown; front grayish brown; anterior vertex relatively narrow, about twice the greatest diameter of scape.

Pronotum dark brown, sparsely gray pruinose. Mesonotal præscutum golden yellow laterally, with four brown stripes that are nearly confluent, the anterior portion of interspaces being infuscated; stripes very vaguely bordered by a slightly darker brown margin, the intermediate pair being divided only by this capillary darkened vitta; scutum similarly dark brown, the median region not paler; scutellum velvety black, the parascutella obscure yellow; postnotal mediotergite light golden yellow. Pleura chiefly light golden yellow, this color occupying the anepisternum, dorsal sternopleurite, pteropleurite, and meron; dorsopleural region and propleura conspicuously blackened; ventral sternopleurite dark gray; pleurotergite dark brown. Halteres blackened. Legs elongate; coxæ dark brown, the midcoxæ more yellow dusted; trochanters brownish black; femora yellow, the tips narrowly but conspicuously blackened; tibiæ obscure yellow, the tips narrowly and weakly infuscated; tarsi elongate, obscure yellow, the terminal segments blackened; spur formula 1–?–2, the mid-legs and all claws being broken. Wings with a strong brownish yellow suffusion, the prearcular region abruptly blackened; cell C and stigmal region weakly infumed; vague dusky seams near outer end of cell M and at two-fifths the length of cell Cu; a dusky seam along anterior cord, interspersed with conspicuous obliterative areas before stigma and along cord; clearer yellow areas in the bases of cells Cu, 1st A and 2d A, and before the dusky spot in cell M; veins deep yellow. Macrotrichia of veins small but abundant, including almost the entire extent of both anal veins; squama with small setæ. Venation: Rs a trifle longer than m-cu; R_{1+2} entire; m-cu at fork of M_{3+4}.

Abdominal tergites reddish brown, the lateral margins darker brown; sternites brown, the basal rings darker, the caudal margins somewhat more fulvous. Ovipositor with the cerci smooth and slender, nearly straight.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*).

This very striking *Tipula* requires comparison with no described member of the genus. The general coloration of the wings is somewhat as in *T. moiwana* (Matsumura), *T. ultima* Alexander, and other similar species, but the highly contrasting wing bases and the striking thoracic pattern are clearly different.

TIPULA MACHIDAI sp. nov. Plate 1, fig. 2; Plate 2, figs. 25 to 28.

General coloration gray, the præscutum with four conspicuous dark brown stripes; nasus lacking; antennal flagellum black; tibiæ and tarsi black; wings yellowish, the stigma dark brown, the apex narrowly darkened; R_{1+2} entire; basal abdominal tergite gray; segments two and three yellow, the tergites trivittate with black, the remaining segments blackened; male hypopygium with the tergite broadly emarginate caudally, the median area produced into a deflexed plate.

Male.—Length, about 15 millimeters; wing, 18.5.

Frontal prolongation of head gray, without nasus; palpi black. Antennæ with the scape and pedicel light yellow; flagellum black throughout; basal enlargements of segments small; verticils elongate, subequal in length to the basal segments, longer than the outer ones. Head gray, the center of vertex infuscated; no vertical tubercle.

Mesonotal præscutum gray, with four conspicuous dark brown stripes, the intermediate pair separated by a capillary gray line; pseudosutural foveæ lacking; scutum gray, the centers of lobes dark brown; scutellum dark gray, with a capillary vitta on basal portion; postnotum dark gray. Pleura light gray. Halteres yellow, the knobs dark brown. Legs with the coxæ gray; trochanters yellow; femora brownish yellow, clearer yellow basally, the tips broadly blackened, most extensively so on the fore femora; remainder of legs black; tibial spur formula 1–2–2; claws small, simple. Wings (Plate 1, fig. 2) with the ground color yellowish, the prearcular and costal regions deeper yellow; stigma oval, dark brown; wing apex narrowly but conspicuously darkened; very narrow dark seams along cord; distal half of vein 2d A seamed with brown; veins dark brown, Sc, R_1, and R_{1+2} more yellowish. No macrotrichia on squama, those of veins small and scanty. Venation: Rs long, about twice m-cu; R_{1+2} entire, sinuous; cell 1st M_2 elongate, about equal in length to cell M_1; distal section of M_3 strongly sinuous.

Abdomen with basal tergite light gray; segments two and three yellow, the tergites trivittate with black; on outer segments, including hypopygium, uniformly blackened. Male hypopygium (Plate 2, fig. 25) with the tergite, *9t*, entirely distinct from the sternite, *9s*; basistyle, *b*, entirely fused with sternite. Ninth tergite (Plate 2, fig. 26, *9t*) transverse, the lateral angles produced, the median area extended into a deflexed plate that is invisible from above; caudal half of tergite with very abundant small setæ. Ninth sternite (Plate 2, fig. 27, *9s*,) with the median area entirely but narrowly membranous; eighth sternite, *8s*, unarmed, its margin transverse. Outer dististyle (Plate 2, fig. 28, *od*) a pale, flattened lobe, its length about two and one-half times its greatest width. Inner dististyle (Plate 2, fig. 28, *id*) simple, relatively long and narrow, the distal third blackened, the "heel" portion produced into a small spine.

Habitat.—Japan (Honshiu).

Holotype, male, Mitake, Musashi, April 26, 1931 (*J. Machida*).

I take great pleasure in naming this crane fly in honor of my old friend Dr. Jiro Machida. A careful study of the approximately one hundred Japanese species of *Tipula* known to me has failed to show a single one with which the present fly can be compared profitably. *Tipula nippoalpina* Alexander likewise lacks the nasus but is in all other respects a very different fly. In its general appearance, the present form bears a superficial resemblance to *T. dichroistigma* Alexander, but the relationship between the two seems remote. Likewise, I cannot satisfactorily place this fly in any of the subgenera of *Tipula* as defined by Edwards.[2]

TIPULA (FORMOTIPULA) LUTEICORPORIS sp. nov. Plate 1, fig. 3; Plate 2, figs. 29 to 31.

Thorax and abdomen orange-yellow; head black; antennæ black, the pedicel light yellow; knobs of halteres dark brown; legs black, the femoral bases obscure yellow; wings dusky, R_{1+2} preserved; male hypopygium with a single dististyle; eighth sternite broad, each caudolateral angle produced into a small setiferous lobule.

Male.—Length, about 10 millimeters; wing, 11.8.

Frontal prolongation of head black; nasus distinct, black, slightly deflexed; palpi black. Antennæ 12-segmented, black, with the exception of the light yellow pedicel; basal enlargements of flagellar segments small; terminal segment subequal

[2] Ann. & Mag. Nat. Hist. X 8 (1931) 73–82.

in length to penultimate, but with outer half strongly narrowed; longest verticils about equal to the segments. Head black; vertical tubercle scarcely developed.

Mesothorax entirely light orange-yellow. Halteres pale yellow, the knobs dark brown. Legs with the coxæ and trochanters orange; femora obscure yellow basally, the distal third passing into black; tibiæ and tarsi black, the latter elongate. Wings (Plate 1, fig. 3) with a strong dusky tinge; stigma oval, dark brown; veins black; obliterative areas at distal third of Rs, all of basal section of M_{1+2}, basal third of second section of M_{1+2}, and virtually all of basal section of M_3. Venation: R_{1+2} entirely preserved and provided with about ten macrotrichia.

Abdomen, including hypopygium, entirely orange-yellow. Male hypopygium (Plate 2, fig. 29) with the tergite, *9t*, entirely separate from the sternite, *9s*; basistyle, *b*, with about the central third fused with the sternite, the dorsal suture shorter than the ventral. Ninth tergite (Plate 2, fig. 30, *9t*) narrowly transverse; viewed from above with an acute blackened point on either side of midline; viewed laterally, each of these blackened points is seen to be very high and with the profile irregularly toothed. Eighth sternite (Plate 2, fig. 31, *8s*) broad, forming a sheath, each caudolateral angle produced into a small lobe that bears long setæ; caudal margin between these lobes truncate or nearly so. Apparently a single dististyle (Plate 2, fig. 29, *d*), the apical beak very slender, acute.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,000 feet, August 14, 1931 (*Franck*).

Tipula (*Formotipula*) *luteicorporis* is readily told from all other described species of the subgenus by the uniform orange-yellow coloration of the thorax and abdomen, in conjunction with the persistence of vein R_{1+2}. *Tipula* (*F.*) *exusta* Alexander (western China) has a somewhat similar coloration but with vein R_{1+2} atrophied and with a distinctly different male hypopygium.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) LACKSCHEWITZIANA sp. nov. Plate 1, fig. 4; Plate 2, fig. 32.

Belongs to the *tripunctata* group; general coloration yellow, the pronotum, præscutum, and postnotal mediotergite with an intense black median vitta, the scutum and scutellum with a common V-shaped black pattern, the point at the caudal margin

of scutellum; knobs of halteres infuscated; femora and tibiæ yellow, narrowly tipped with black; wings light yellow, almost immaculate, the stigmal area restricted; abdomen yellow, the tergites with a median black stripe; caudal margins of basal sternites narrowly blackened; male hypopygium with the dististyle bidentate at apex; gonapophyses with delicate setulæ over most of surface.

Male.—Length, about 7 to 7.5 millimeters; wing, 8.5 to 9.

Female.—Length, about 8 to 8.5 millimeters; wing, 9 to 9.5.

Rostrum brownish yellow; palpi black. Antennæ with the scape, pedicel, and basal two or three flagellar segments yellow, the outer segments passing into dark brown; flagellar segments elongate-oval, the verticils exceeding the segments. Head yellow, the central portion of vertex more infuscated.

Pronotum yellow, with a black median line. Mesonotal præscutum yellow with a single median vitta, intensely black and very clearly defined, widest in front, more narrowed behind, ending at the suture; scutum and scutellum yellow, with two black areas that begin at the suture, converging behind, meeting to form a V at the posterior margin of scutellum; postnotal mediotergite yellow laterally, broadly blackened medially. Pleura and pleurotergite yellow. Halteres with the stem yellow, the knobs infuscated. Legs with the coxæ and trochanters yellow; femora yellow, the tips narrowly but conspicuously black, the amount subequal on all legs; tibiæ yellow, the tips narrowly blackened; tarsi black. Wings (Plate 1, fig. 4) light yellow, more saturated on cephalic third, almost unmarked; stigmal darkening evidenced only by narrow seams to free tip of Sc_2 and R_2; veins dark brown. Venation: Sc_1 ending about opposite midlength of Rs, Sc_2 longer; free tip of Sc_2 longer than R_2, in cases as much as one-half longer; m-cu variable in position, from before to shortly beyond the fork of M.

Abdominal tergites yellow, with a very distinct black median vitta that tends to widen out at the caudal margins of the individual segments, forming triangular or ⊥-shaped markings; hypopygium chiefly blackened; sternites yellow, the caudal margins of the basal segments narrowly blackened. Male hypopygium (Plate 2, fig. 32) with the tergite, *9t*, large, narrowed outwardly, the nearly truncate apex about as wide as the length of the sclerite. A single dististyle, *d*, the apex bidentate, the outer face at base protuberant and with abundant erect setæ. Gonapophyses, *g*, with the mesal-apical angle long and slender, the surface of apophysis covered with microscopic setulæ almost

to apex of spine. Ædeagus very large, with a subapical marginal lobe.

Habitat.—Western China to Tibet.

Holotype, male, Mount Omei, Szechwan, China, altitude 9,000 feet, July 29, 1931 (*Franck*). Allotopotype, female. Paratopotypes, 6 males and females, July 20 to 29, 1931. Paratypes, 1 female, Mount Omei, altitude 8,500 feet, July 29, 1931; 1 male, Tang-Gu, China-Tibet border, altitude 14,000 feet, August 3 to 6, 1930 (*Graham*), in United States National Museum.

I take great pleasure in naming this interesting high-altitude *Limonia* in honor of Dr. P. Lackschewitz, distinguished authority on the Tipulidæ of the Palæarctic Region. The species is closest to western palæarctic forms such as *stigma* (Meigen) and *tripunctata* (Fabricius). By Lackschewitz's key to the European species of *Limonia* sensu strictu [3] it runs to *stigma*, differing especially in the details of the coloration of the thorax and wings and in the structure of the male hypopygium. There appears to be no closely allied form among the described Himalayan and Japanese species.

LIMONIA (LIMONIA) COMMIXTA sp. nov. Plate 1, fig. 5; Plate 2, fig. 33.

Belongs to the *pendleburyi* group; general coloration uniform ocher-yellow, the dorsal pleural region infuscated; eyes confluent above; legs yellow, the femoral tips weakly infuscated; wings with a yellow tinge, the subcircular stigma dark brown; Sc_1 ending beyond the fork of Rs, Sc_2 at its tip; m-cu beyond fork of M; abdomen bicolorous, the bases of the individual segments pale; male hypopygium with a complex development of the ventromesal lobe of basistyle.

Male.—Length, about 5.4 millimeters; wing, 6.2.

Rostrum brown, of moderate length; palpi with the basal two segments infuscated, the terminal two segments somewhat paler. Antennæ dark brown throughout; flagellar segments oval, the verticils exceeding the segments. Head dark gray; eyes confluent on anterior vertex.

Pronotum dark brown. Mesonotum almost uniformly ocher-yellow, without distinct markings, the postnotum darker. Pleura with the dorsal portion extensively infuscated, the ventral pleurites narrowly yellow. Halteres weakly infuscated. Legs with the coxæ obscure yellow, the fore coxæ more infuscated; trochanters yellow; femora yellow, the tips weakly infuscated; tibiæ and tarsi obscure yellow. Wings (Plate 1, fig. 5) with

[3] Ann. Naturhist. Mus. Wien 42 (1928) 233–234.

a yellowish tinge, the costal region somewhat clearer yellow; stigma subcircular, dark brown; veins pale brown, more yellowish in the flavous areas. Venation: Sc of unusual length for a member of this subgenus, Sc_1 ending beyond the fork of Rs, Sc_2 at its tip; Rs in oblique alignment with basal section of R_{4+5}, nearly three times the length of the latter vein; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 elongate, subequal to vein M_{1+2} beyond it; m-cu more than one-fourth its length beyond the fork of M; anal veins slightly convergent at bases.

Abdomen bicolorous, the bases of the individual segments obscure yellow, the apices brownish black, the amount of the latter including more than one-half the segment on the tergites, much narrower on the sternites; hypopygium obscure yellow. Male hypopygium (Plate 2, fig. 33) with the caudal margin of the large tergite, *9t*, transversely rounded. Basistyle, *b*, with the ventromesal lobe very large, fully as long as the style itself, complex in structure, the outer margin being notched and bearing two slender lobes, *mb*, that are of unequal stoutness, both bearing elongate setæ at tips. A single complex dististyle, *d*. Gonapophyses, *g*, usually broad, the mesal-apical beak slender, the surface with delicate parallel striæ, as in the group.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,000 feet, August 3, 1931 (*Franck*).

Limonia (*Limonia*) *commixta* is allied to species such as *L.* (*L.*) *pendleburyi* Edwards (Pahang), differing most evidently in the more *Libnotes*-like venation, as the straight Rs and position of m-cu, together with the structure of the male hypopygium, which is quite different from the other described members of the group. The venation as found within the limits of this single restricted aggregation of species in eastern Asia closely connects the two types of venation held as typical of the subgenera *Limonia* and *Libnotes*.

LIMONIA (DICRANOMYIA) SHINANOENSIS sp. nov. Plate 1, fig. 6.

General coloration brownish black (probably pruinose in dry specimens); antennal scape and pedicel black, the flagellar segments bicolorous, their bases yellow, the apices pale brown; legs yellow, the tips of femora narrowly but conspicuously blackened; tibiæ uniformly obscure yellow; wings whitened, with a heavy brown pattern that is chiefly costal in distribution, the dark areas approximately as wide as the interspaces.

Female.—Length, about 8.5 millimeters; wings, 7.2.

Described from an alcoholic specimen.

Rostrum and palpi brownish black. Antennæ with the scape and pedicel black, the flagellum abruptly brownish yellow, somewhat bicolorous, the basal half of each segment more yellow than the apex; flagellar segments oval, the verticils shorter than the segments; terminal segment about one-third longer than the penultimate, narrowed apically. Head blackish; anterior vertex narrow.

General coloration of thorax brownish black, the præscutum apparently darker medially; pleura variegated with paler on pteropleurite and dorsal sternopleurite; thorax probably heavily pruinose in fresh specimens. Halteres pale, the knobs blackened. Legs with the coxæ blackened, narrowly paler at tips; trochanters obscure yellow; femora yellow, the tips narrowly but conspicuously blackened; tibiæ obscure yellow throughout; tarsi obscure yellow, the terminal three segments blackened; claws with a conspicuous subbasal spine, with an additional series of about three more basal teeth, these being progressively larger outwardly. Wings (Plate 1, fig. 6) whitish, including the prearcular region; a heavy dark brown pattern, chiefly costal and apical in distribution; four major costal areas before the more extensively darkened apex, the fourth area being the stigmal; these areas solidly darkened in the costal and subcostal cells, their centers paling to grayish in the radial field; subquadrate in outline, not strongly narrowed in the radial field (as in *frivola* and *shirakii*), a very little more extensive than the pale interspaces; additional dark areas include a large spot at fork of Rs, confluent with the stigma; a smaller area on r-m; cord and outer end of cell 1st M_2 seamed with brown; large, paler brown areas at ends of veins Cu, 1st A, and 2d A; dusky washes covering most of cell M and crossing the basal portions of cells Cu, 1st A, and 2d A to the axillary margin; veins dark, paler in the whitened areas. Venation: Sc_1 ending shortly beyond origin of Rs; Sc_2 (or a supernumerary crossvein) far from tip of Sc_1, at near midlength of Sc; m-cu close to fork of M.

Abdomen dark brown, the caudal margins of the segments narrowly but conspicuously ringed with pale; ovipositor with the shields pale yellow, the valves darker. Cerci slender and nearly straight.

Habitat.—Japan (Honshiu).

Holotype, alcoholic female, Kumanoyu, Shinano, July 6, 1931 (*H. Yokouchi*). Type in collection of Kyushu Imperial University.

I consider it somewhat doubtful that *Limonia* (*Dicranomyia*) *shinanoensis* belongs to the *pulchripennis* group, all other known members of which have the bases and apices of the tibiæ conspicuously darkened. The present fly has a wing pattern that is most like that of *L.* (*D.*) *kirishimana* Alexander (Japan), differing most evidently in the much broader costal interspaces, which are here nearly as extensive as the dark areas; in *kirishimana* the pale areas in cell C are scarcely one-third to one-fourth as extensive as the dark markings.

LIMONIA (DICRANOMYIA) TRISPINULA sp. nov. Plate 1, fig. 7; Plate 2, fig. 34.

General coloration light yellow; femora with more than distal half brownish black; tibiæ brownish black; wings with a faint brownish tinge, the oval stigma dark brown; Sc_1 subequal in length to Rs; m-cu more than one-third its length before the fork of M; male hypopygium with the rostral prolongation of the ventral dististyle trispinous.

Male.—Length, about 4.5 millimeters; wing, 5.

Most of head destroyed; posterior vertex extensively yellowish, sparsely pruinose.

Mesonotum and pleura uniformly pale yellow. Halteres pale, the knobs weakly infuscated. Legs with the coxæ and trochanters pale yellow; femora pale yellow basally, more than distal half brownish black; tibiæ brownish black; tarsi broken. Wings (Plate 1, fig. 7) with a faint brown tinge, the oval stigma dark brown, conspicuous; veins dark brown, those of the basal third of wing paler. Macrotrichia of veins beyond cord long and conspicuous; basad of cord sparse to lacking, there being none on 1st A and only three or four at outer end of 2d A. Venation: Sc_1 ending just before origin of Rs, Sc_2 far from its tip, Sc_1 alone being nearly as long as Rs alone; cell 1st M_2 closed; m-cu more than one-third its length before the fork of M.

Abdomen, including hypopygium, pale. Male hypopygium (Plate 2, fig. 34) with the caudal margin of tergite, *9t*, broadly emarginate. Basistyle, *b*, short, the ventromesal lobe large. Ventral dististyle, *vd*, large and fleshy, its rostral prolongation small and relatively slender, provided with three rostral spines that are placed in a row on basal half of prolongation, the outermost somewhat smaller. Dorsal dististyle strongly curved, the actual tip slightly recurved. Gonapophyses, *g*, with the mesal-apical lobe relatively slender, gently curved, the tips acute.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,000 feet, August 3, 1931 (*Franck*).

Limonia (*Dicranomyia*) *trispinula* is readily told from similar regional species by the dark stigma of wings, the long Sc_1, basal position of m-cu, and other characters. Since the type is unique, it is not entirely certain that the feature of a trispinous rostral prolongation is constant.

LIMONIA (RHIPIDIA) GARRULA sp. nov. Plate 1, fig. 8; Plate 2, fig. 35.

Belongs to the *rostrifera* group; general coloration dark brown, the thoracic pleura yellowish gray, variegated with dark brown; antenna (male) with all but the terminal flagellar segment long-bipectinate; tarsi extensively snowy white; wings with the apex and stigma conspicuously darkened; extensive milky white areas before and beyond stigma; abdominal segments black, the caudal margins buffy yellow; male hypopygium with two rostral spines.

Male.—Length, about 6 millimeters; wing, 6.

Rostrum about one-half the length of remainder of head, black; palpi concolorous. Antennæ (male) with the scape dark brown; pedicel brownish yellow; flagellar segments with the basal enlargement and branches dark brown, the long apical pedicel whitish; terminal segment uniformly darkened; flagellar segments 1 to 11, inclusive, each with two long branches, those of the first and eleventh segments slightly more than one-half longer than the segment; longest branches (at midlength of organ) slightly exceeding three times the segments; terminal segment simple, slightly exceeding twice the penultimate segment. Head gray.

Mesonotum dark brown, opaque; humeral region of præscutum obscurely brightened. Pleura yellowish gray, the ventral sternopleurite extensively dark brown; a small brown spot on ventrocephalic portion of anepisternum. Halteres pale yellow. Legs with the fore coxæ small, dark brown; remainder of coxæ and all trochanters yellow; femora and tibiæ yellowish brown to light brown, the tips of the former narrowly darkened; proximal half of basitarsi dark brown, with almost the remainder of tarsi snowy white, only the terminal segment again infuscated; claws with a sharp basal spine. Wings (Plate 1, fig. 8) with the ground color very faintly brownish, the large oval stigma and a confluent cloud over anterior cord dark brown; wing apex in cells R_2 and R_3 conspicuously darkened; very large and conspicuous milky white areas before and beyond stigma; origin of Rs and posterior cord very narrowly and insensibly seamed with brown; veins pale brown, more whitish in the milky areas. Ve-

nation: Sc_1 ending about opposite one-third the length of Rs, Sc_2 exactly opposite origin of Rs; free tip of Sc_2 lying a little distad of level of R_2; cell M_2 open by atrophy of *m*; *m-cu* a short distance beyond fork of M.

Abdominal segments black, their caudal margins broadly and conspicuously ringed with buffy yellow, the latter color including from about one-fourth to nearly one-half the entire segment, the amount decreasing on outer segments; terminal segments dark brown; ventral dististyle of male hypopygium conspicuously whitened. Male hypopygium (Plate 2, fig. 35) with the tergite, *9t*, transverse, the caudal margin very gently emarginate. Basistyle, *b*, small, the ventromesal lobe proportionately large. Ventral dististyle, *vd*, a large fleshy lobe, the rostral prolongation small, with two short, gently curved spines that arise from a short, common tubercle. Gonapophyses, *g*, with the mesal-apical angle slender.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*).

Limonia (*Rhipidia*) *garrula* is very different from all other described members of the group. White tarsi are likewise found in *morionella* Edwards and *luteipleuralis* Alexander, but these species have the wings clear except for the stigma and with the mesonotum polished black. As stated elsewhere, I am inclined to believe that the members of the *rostrifera* group are a quite different offshoot from typical *Rhipidia* and may well warrant the erection of a new subgeneric group.

LIMONIA (GERANOMYIA) BIFURCULA sp. nov. Plate 1, fig. 9; Plate 2, fig. 36.

General coloration of mesonotum reddish brown, the præscutum with three blackish stripes, the median one continued caudad onto base of scutellum; rostrum and antennæ black throughout; knobs of halteres brownish black; legs brownish yellow to brown; wings brownish yellow, with a heavy brown pattern that is chiefly costal in distribution; a supernumerary crossvein in cell Sc; Sc_1 ending about opposite two-thirds the length of Rs; cell 1st M_2 long and narrow; male hypopygium with the rostral prolongation of the large ventral dististyle long and slender, at its base bearing a single, powerful, decurved spine, the two taken together forming a conspicuous fork; dorsal dististyle a small, nearly straight, needlelike rod.

Male.—Length, excluding rostrum, about 6 to 6.5 millimeters; wing, 6 to 6.5; rostrum, about 2.2 to 2.5.

Female.—Length, excluding rostrum, about 7 to 8 millimeters; wing, 6 to 7.5; rostrum, about 2.2 to 3.

Rostrum and palpi black. Antennæ black throughout; flagellar segments suboval, with short, inconspicuous verticils. Head gray, the posterior vertex with a blackish area on either side of the median line.

Mesonotum brown, more or less pruinose; a capillary, median, blackish vitta extending from the præscutum, crossing the scutum onto the scutellum; slightly broader blackish sublateral stripes; lateral margins and posterior interspaces of præscutum, median area of scutum, and the scutellum somewhat more reddish brown; postnotum black, gray pruinose. Dorsal pleurites brownish black, the ventral sclerites, including the sternopleurite and meron, more yellowish. Halteres yellow, the knobs brownish black. Legs with the coxæ and trochanters yellow; femora obscure brownish yellow; tibiæ and tarsi somewhat darker brown. Wings (Plate 1, fig. 9) with a brownish yellow ground color, the prearcular and costal regions clearer yellow; a restricted dark brown pattern, including about seven costal areas, the third at origin of Rs and fourth at tip of Sc separate; last two areas at ends of the outer radial veins; cord and outer end of cell 1st M_2 narrowly seamed with brown; scarcely evident marginal washes at ends of medial, cubital, and anal veins; veins brown, darker in the infuscated areas. Venation: A supernumerary crossvein in cell Sc at shortly beyond midlength; Sc_1 ending about opposite two-thirds the length of Rs, Sc_2 at its tip; cell 1st M_2 long, exceeding the veins beyond it; m-cu close to fork of M; anal veins at origin very gradually divergent.

Abdominal tergites dark brown, the caudal margins very narrowly pale; basal sternites obscure yellow, the subterminal segments darker; hypopygium dark brown. Male hypopygium (Plate 2, fig. 36) with the tergite, *9t,* deeply and narrowly notched medially, the lobes broadly obtuse. Basistyle, *b,* small. Ventral dististyle, *vd,* large and fleshy, the rostral prolongation long and slender, at base bearing a single, powerful, decurved spine that is evidently formed by the union of the usual two spines, the suture being faintly indicated. Dorsal dististyle a small, nearly straight, slender rod, the tip very acute. Gonapophyses, *g,* with the mesal-apical lobe slender. Lateral portions of ædeagus with delicate setulæ.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 3,500 feet, July 9, 1931 (*Franck*). Allotopotype, female. Paratopotypes, 8 of both sexes, with the types; 2 females, August 17, 1931.

Limonia (*Geranomyia*) *bifurcula* is generally similar to species such as *L.* (*G.*) *avocetta* (Alexander), differing from all such species where the male sex is known by the peculiar structure of the rostral prolongation of the ventral dististyle and its spine. A few members of the same group are known only from the female sex (as *septemnotata* Edwards, of Formosa, and *flaviventris* Brunetti, of the eastern Himalayas); these differ most evidently in the details of coloration. The type of male hypopygium found in *bifurcula* is somewhat approached by that of *L.* (*G.*) *feuerborni* Alexander (East Indian Islands), but the latter species has unspotted wings.

ANTOCHA (ANTOCHA) PALLIDELLA sp. nov. Plate 1, fig. 10; Plate 3, fig. 37.

General coloration pale yellow, including the antennæ and halteres; tips of femora and tibiæ narrowly blackened; wings subhyaline, with a sparse dark pattern, indicated chiefly by cloudings of the veins comprising the cord and outer end of cell 1st M_2; m-cu a little more than its own length before fork of M; male hypopygium with each caudal-lateral angle of tergite bearing a small rounded tubercle; gonapophyses simple; phallosome apparently reduced to the elongate ædeagus.

Male.—Length, about 4.5 millimeters; wing, 5.3.

Rostrum pale yellow, the palpi slightly darker. Antennæ short, pale yellow throughout; flagellar segments oval, the verticils not exceeding the segments. Head testaceous-yellow.

Mesonotum and pleura pale yellow. Halteres pale throughout. Legs pale yellow, the tips of the femora narrowly but conspicuously blackened; tibiæ similarly but even more narrowly blackened; terminal tarsal segments blackened. Wings (Plate 1, fig. 10) broad, subhyaline, the small oval stigma darker; veins pale, the cord, m-cu, and outer end of cell 1st M_2 darker brown. Venation: R_2 lying some distance proximad of r-m, R_{2+3} being about one-half as long as R_{4+5}; m-cu more than its own length before fork of M.

Abdomen yellow, the outer tergites marked with brownish at centers of disk; hypopygium pale yellow. Male hypopygium (Plate 3, fig. 37) with the tergite, *9t*, transverse, the outer lateral angles of the caudal margin produced into low, rounded, seti-

ferous lobes. Outer dististyle, *od*, a gently arcuate darkened blade, the apex obtuse. Gonapophyses, *g*, appearing as simple flattened rods, their tips acutely pointed, these rods subtending the simple, sinuous ædeagus, *a*.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*).

The nearest ally of the present fly is undoubtedly *Antocha* (*Antocha*) *nigribasis* Alexander, likewise from the mountains of Szechwan, which differs most evidently in the usually darkened wing base, even more basal position of m-cu, and the details of the male hypopygium, as the tuberculate caudal margin of the ninth tergite. The two species differ from all allied regional members of the genus in the pale yellow coloration of the body, the narrowly blackened tips of the femora, the basal position of m-cu, and the details of venation of the radial field, as the brevity of R_{2+3} when compared with R_{4+5}.

ANTOCHA (ANTOCHA) SETIGERA sp. nov. Plate 1, fig. 11; Plate 3, fig. 38.

General coloration gray; præscutum with a median brown stripe; antennal flagellum black; knobs of halteres infuscated; legs brown; wings whitish, especially the prearcular region; m-cu about one-half its length before the fork of M; veins beyond cord with unusually abundant macrotrichia; abdominal tergites dark brown, the basal sternites dark medially, paler laterally; male hypopygium with the phallosome relatively narrow, at apex dividing into two short arms.

Male.—Length, about 5.3 millimeters; wing, 6.

Rostrum brown; palpi dark brown. Antennæ (male) of moderate length, if bent backward extending to just beyond the wing root; scape brown, remainder of organ black; flagellar segments oval, terminal segment two-thirds the length of the penultimate; verticils shorter than the segments. Head gray.

Mesonotum dark gray, the præscutum with a median brown stripe and with scarcely indicated lateral stripes. Pleura gray. Halteres pale, the knobs infuscated. Legs with the coxæ yellow, the fore coxæ infuscated on basal half; trochanters yellow; remainder of legs brown. Wings (Plate 1, fig. 11) whitish subhyaline, the prearcular region more milky white; stigma pale brown, ill-delimited; veins brown, pale in the prearcular region. Macrotrichia of veins unusually abundant and conspicuous, being found on distal half of R_3, all of outer section of R_{4+5}, the entire length of all veins issuing from cell 1st M_2, almost the

entire length of distal section of Cu_1 and outer half of M_{3+4}; a few scattered trichia on second section of M_{1+2} and with three or four trichia on distal half of vein 2d A, these widely separated. Venation: R_2 unusually faint, about in transverse alignment with r-m; cell 1st M_2 small, shorter than vein M_{1+2} beyond it; m-cu about one-half its length before fork of M.

Abdominal tergites dark brown; basal sternites darkened medially, paler laterally; hypopygium dark brown. Male hypopygium (Plate 3, fig. 38) with the tergite, *9t*, transverse, the central portion of cephalic half with very numerous setæ, the more-lateral ones larger and coarser. Outer dististyle, *od*, gently arcuated, the distal half blackened, the tip obtusely rounded. Inner dististyle with the apex provided with abundant coarse setæ. Gonapophyses, *g*, appearing as simple, flattened, dusky rods, their tips subacute. Phallosome, *p*, of moderate size, narrowed outwardly, the apex dividing into two short, divergent arms.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*). Paratopotype, male, altitude 3,500 feet, August 16, 1931 (*Franck*).

Antocha (*Antocha*) *setigera* is told from all regional species of the genus by the structure of the male hypopygium, especially of the phallosome. The coloration of the body and wings and the trichiation of the wing veins likewise furnish somewhat distinctive features.

PEDICIINI

PEDICIA BRACHYCERA sp. nov. Plate 1, fig. 12; Plate 3, fig. 40.

Female.—Length, about 30 millimeters; wing, 25.

Characters much as in *Pedicia daimio* (Matsumura).

Rostrum and palpi black, the terminal segment of the latter subequal to the penultimate. Antennæ much shorter than in *daimio*, 15-segmented, shorter than the head, dark brown throughout; flagellar segments relatively short and crowded. Head gray, the vertical tubercle with a circular depression.

Præscutum light gray, with three darker gray stripes, the median one split on anterior half by a vague paler median vitta. Halteres and legs about as in *daimio*. Wings (Plate 1, fig. 12) with the usual pattern of the genus, the dark seam on distal section of vein Cu_1 becoming obsolete before midlength of vein and thus not reaching the margin, as is the case in *daimio*.

Abdomen conspicuously gray, much darker and more extensively suffused than in *daimio,* the dorsomedian line of tergites darker grayish brown, very narrowly interrupted by the rufous incisures; sternites with the lateral margins broadly gray. Ovipositor with the cerci longer than in *daimio.*

Habitat.—Japan (Honshiu).

Holotype, female, Shirouma-dake, Japanese Alps, August 8, 1931 (*Machida*).

The present insect certainly appears to be distinct from *daimio* in the characters outlined above, notably the short antennæ with small crowded flagellar segments. The antennæ of both of these species have only fifteen segments, whereas the normal number for the genus is sixteen. The condition in the larger members of the closely allied genus (or subgenus) *Tricyphona,* where the number of antennal segments ranges from eleven to sixteen, shows clearly that we are here dealing with a very plastic character that cannot be trusted for generic or tribal separation. The antennal flagella of *daimio* (Plate 3, fig. 39) and of *brachycera* (Plate 3, fig. 40) are herewith compared, the organs being drawn to scale.

PEDICIA SUBTRANSVERSA sp. nov. Plate 1, fig. 13; Plate 3, fig. 41.

General coloration light gray, the præscutum with three brown stripes, the median one split by a capillary gray vitta; wings whitish subhyaline, with the usual triangular dark pattern on disk, the seam on vein Cu_1 continued to margin; cord more nearly transverse than in other species of the genus; R_{1+2} about two-thirds as long as m-cu; abdomen with the basal segments yellow, the tergites with a nearly continuous median stripe; male hypopygium with the dististyle single, terminal in position, the outer margin with four or five spines.

Male.—Length, about 19 millimeters; wing, 17.

Rostrum very short, black; palpi black, the terminal segment about one-half longer than the penultimate. Antennæ with the scape and pedicel black; remainder of organ broken. Head dark gray, with a moderately developed vertical tubercle.

Pronotum fulvous, infuscated laterally. Mesonotal præscutum light gray, with three brown stripes, the median one somewhat darker, divided by a capillary gray vitta, the stripe narrowed behind and not reaching the suture; lateral stripes more pruinose; scutum gray, the median area more brownish fulvous; scutellum obscure yellow; postnotal mediotergite dark brown, sparsely pruinose, the cephalic portion narrowly more yellowish. Pleura chiefly light gray, the dorsopleural region and pleuro-

tergite more infuscated. Halteres pale yellow, the knobs weakly darkened. Legs with the coxæ light gray; trochanters obscure yellow; femora and tibiæ yellow, the tips narrowly blackened; tarsi black, the proximal portions of basitarsi more or less brightened. Wings (Plate 1, fig. 13) whitish subhyaline, the costal margin light brown, paler beyond the humeral crossvein and before stigma; the usual dark pattern of the genus, including extensive darkenings of cells R and M, a semicircular area at origin of Rs, and a continuous darkening in cells R_2 and R_3; seam along vein Cu_1 continued to margin; veins pale yellow, including the darkened areas, in contrast with which they are very conspicuous. Venation: R_{1+2} relatively long, approximately two-thirds of m-cu; cord subtransverse, much less oblique than in the typical members of the genus.

Abdomen with the basal segments yellow, with a nearly continuous dorsomedian brown vitta, narrower and paler on the basal ring; sternites with their caudal margins narrowly light brown; lateral triangular areas on both tergites and sternites near caudal margins of segments, the areas becoming larger on the outer segments. Male hypopygium (Plate 3, fig. 41) with the dististyle, *d*, single, terminal in position; outer margin of style with a series of four or five spines, the more-distal ones larger; disk of style set with smaller black spines. Interbasal process, *i*, a small, narrowly spatulate blade.

Habitat.—Japan (Honshiu).

Holotype, male, Shirouma-dake, Japanese Alps, August 8, 1931 (*Machida*).

Pedicia subtransversa differs from the other species of the genus in the less oblique cord of the wings, which is here almost exactly as in some species of *Tricyphona*. The present species is placed in *Pedicia* chiefly on the possession of the characteristic wing pattern of the group, since the male hypopygium is likewise scarcely typical of the genus, the dististyle being terminal in position. There are two species of *Tricyphona* in Japan (*gaudens* Alexander and *grandior* Alexander) that closely approach *Pedicia,* and the characters hitherto used for the separation of the two groups are gradually becoming untenable.

DICRANOTA (DICRANOTA) NIPPOALPINA sp. nov. Plate 1, fig. 14; Plate 3, fig. 42.

General coloration pale yellow; head light gray; wings relatively long and narrow; Rs more than twice R_{2+3+4}; cell M_2 open; male hypopygium with the interbase at apex extended into a long powerful spine.

Male.—Length, about 4.5 millimeters; wing, 5.5.

Rostrum pale; basal segments of palpi pale, the outer segments infuscated. Antennæ broken. Head clear light gray; vertex very broad.

Pronotum, mesonotum, and pleura entirely pale yellow, unmarked. Halteres pale, the knobs weakly infuscated. Legs with the coxæ and trochanters pale yellow; femora very pale brown; tibiæ and tarsi whitish, the terminal segments of the latter darkened. Wings (Plate 1, fig. 14) long and narrow, pale yellow throughout; veins pale, not clearly apparent in balsam mounts. Venation: Sc_1 ending shortly before the supernumerary crossvein in cell R_1, Sc_2 not clearly evident in the unique type; R_{2+3+4} about one-third longer than R_{2+3}; cell M_2 open.

Abdomen yellow. Male hypopygium (Plate 3, fig. 42) with the caudal margin of tergite, *9t*, nearly transverse, conspicuously hairy; lateral arms appearing as small, flattened, gently curved, pale blades, their tips obtuse. Basistyle, *b*, with the outer lobe short and stout, with long setæ and a few spines; mesal face of basistyle near cephalic end with a group of very long coarse setæ. Interbase, *i*, at apex bent at nearly a right angle into a long acute spine.

Habitat.—Japan (Honshiu).

Holotype, male, Shirouma-dake, Japanese Alps, August 8, 1931 (*Machida*).

Dicranota (*Dicranota*) *nippoalpina* is very distinct from the other species of the subgenus in eastern Asia in the almost uniform pale yellow color of the body and wings and in the long, nearly straight, radial sector.

DICRANOTA (RHAPHIDOLABIS) SINOALPINA sp. nov. Plate 1, fig. 15; Plate 3, fig. 43.

General coloration gray; antennæ black throughout, 13-segmented; mesonotal præscutum with a median blackish stripe; knobs of halteres infuscated; legs pale yellow; wings subhyaline, the stigmal area very slightly darkened; R_{2+3+4} distinct; cell 1st M_2 open; male hypopygium with the tergite not or scarcely produced medially, setiferous; interbase a stout rod, the apex acute.

Male.—Length, about 4.5 millimeters; wing, 5.

Female.—Length, about 5.5 millimeters; wing, 6.

Rostrum and palpi black. Antennæ short, black throughout. Head gray.

Pronotum and mesonotum dark gray, the præscutum with a conspicuous, median, blackish stripe, the lateral stripes much

less conspicuous. Pleura dark gray. Halteres pale, the knobs infuscated. Legs with the coxæ infuscated; trochanters whitish; remainder of legs pale yellow, the outer tarsal segments darkened; in female, the tips of femora and tibiæ weakly infumed. Wings (Plate 1, fig. 15) subhyaline, the stigmal area very diffusely and faintly darkened; veins very pale. Venation: R_{2+3+4} distinct, subequal to r-m; R_{1+2} about one-half of R_2; cell 1st M_2 open; m-cu oblique, more than one-half its length beyond fork of M.

Abdomen, including hypopygium, brownish black. Male hypopygium (Plate 3, fig. 43) with the caudal margin of the tergite, *9t*, nearly transverse to slightly convex, densely setiferous; lateral angles of tergite produced into small, slender rods. Basistyle, *b*, with the outer apical lobe slightly produced, with small setæ but no spines. Interbase, *i*, a stout rod, the apex narrowed into a slender spine, the surface of style beyond midlength with five or six small setæ. Outer dististyle, *od*, with spinous setæ. Inner dististyle, *id*, slender, the apex obtusely rounded. Phallosome, *p*, depressed, clothed with abundant delicate setulæ, each outer lateral angle a little produced into a slender lobe. Ovipositor with the long valves horn-colored.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*). Allotopotype, female.

Dicranota (*Rhaphidolabis*) *sinoalpina* is most readily told from its few allies in the Himalayas and Japan by the structure of the male hypopygium, in conjunction with the coloration of the body, legs, and wings, and the number of antennal segments. The Himalayan species described by Brunetti (*brunettii* Edwards, synonym *aperta* Brunetti, preoccupied; *fascipennis* Brunetti; *sordida* Brunetti, synonym *indica* Brunetti) all have the antennæ 15-segmented. The range in number of antennal segments in *Rhaphidolabis*, where in a single species (*stigma* Alexander, of western North America) or even in a single specimen, the antennal segments range in number from twelve to fourteen, has been indicated by the writer in another paper.[4]

HEXATOMINI

TROGLOPHILA SZECHWANENSIS sp. nov. Plate 1, fig. 16.

General coloration light brown; wings with cell M_1 present; R_{1+2} shorter than R_{2+3+4}, the latter more than three times R_{2+3} alone.

[4] Proc. U. S. Nat. Mus. 64, art. 10 (1924) 14–15.

Female.—Length, about 4 millimeters; wing, 5.

Rostrum and palpi brown. Antennæ dark brown throughout; flagellar segments cylindrical, the verticils becoming longer and more conspicuous on the outer segments. Head light brown.

Mesonotum light brown, without evident markings. Pleura testaceous-brown, slightly variegated by darker areas on anepisternum, dorsal sternopleurite, and meron. Halteres dusky, the base of stem narrowly yellow. Legs with the coxæ and trochanters yellowish testaceous; femora and tibiæ brown, the tarsi a trifle paler. Wings (Plate 1, fig. 16) with a strong brown tinge; stigma lacking; veins pale brown, the macrotrichia darker. Venation: R_{1+2} shorter than R_{2+3+4}, the latter more than three times R_{2+3} alone and longer than cell 1st M_2; cell M_1 present; m-cu at fork of M.

Abdomen dark brown. Ovipositor with the cerci fleshy, oval, narrowed outwardly, each valve terminating in a slender yellow point; hypovalvæ short and very obtusely rounded.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 3,500 feet, August 17, 1931 (*Franck*).

Troglophila szechwanensis requires comparison only with *T. seticornis* Alexander (eastern China), which differs especially in the venation of the radial field, having R_{2+3+4} short, less than R_{1+2} and shorter than cell 1st M_2.

ERIOCERA (ERIOCERA) HEMICERA sp. nov. Plate 1, fig. 17.

Belongs to the *spinosa* group; general coloration of head and thorax black, gray pruinose; antennæ (male) elongate, a little shorter than the body; mesonotal præscutum with three black stripes; fore and middle femora yellow, their tips narrowly blackened; posterior femora chiefly black; wings with a strong fulvous-brown tinge, the oval stigma pale brown; cell M_1 present; abdomen chiefly fulvous-brown, including the genitalia of both sexes.

Male.—Length, about 16 millimeters; wing, 16; antenna, about 14.

Female.—Length, about 23 millimeters; wing, 19; antenna, about 6.

Rostrum and palpi black. Antennæ (male) 7-segmented, relatively elongate but still shorter than body, black throughout; basal two flagellar segments with long, spinous setæ, there being about twelve to fifteen to each of these segments; on outer segments these spines are more appressed and merge with the

ordinary setæ; terminal segment very small; antennæ (female) 11-segmented, black, the scape slightly paler beneath. Head blackish, gray pruinose.

Mesonotal præscutum with three black stripes, the humeral and sublateral portions more golden yellow pollinose, the interspaces more infuscated; extreme lateral margins of præscutum velvety black; posterior sclerites of mesonotum black, the scutum slightly pollinose, the scutellum more heavily so. Pleura black, gray pruinose. Halteres with the stem brownish yellow, the knobs black. Legs with the coxæ gray pruinose; fore trochanters brown, the others more yellowish; fore and middle femora yellow, their tips narrowly blackened; posterior femora black, only the extreme bases obscure yellow; tibiæ and tarsi black. Wings (Plate 1, fig. 17) with a strong fulvous-brown tinge, the prearcular region and cell Sc light yellow; stigma oval, slightly darker brown than the ground; vague whitish longitudinal streaks in basal cells R to 2d A, inclusive; veins of radial field, M, Cu, and 2d A, narrowly bordered by yellow; veins pale brownish yellow, those of outer medial field very slender and faint. Macrotrichia of costa short but very dense; a few trichia on veins of outer radial field; Sc, Rs, and veins of medial, cubital, and anal fields without trichia. Venation: R_{2+3+4} a little shorter than basal section of R_5; R_{2+3} longer than R_{1+2} but a little shorter than R_3 alone; cell M_1 present, longer than its petiole.

Abdomen with basal tergite black, the succeeding segments fulvous-brown; sternites clearer fulvous; genital segments of both sexes fulvous. Ovipositor with the valves long and slender.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 3,500 feet, August 16, 1931 (*Franck*). Allotopotype, female, August 17, 1931.

I consider that the present species is most nearly allied to *Eriocera* (*Eriocera*) *stricklandi* Edwards, and a few related regional forms. The body is not strikingly hairy and the fulvous-brown ground color of the wings is quite different from the other described members of the *spinosa* group. By Edwards's key to the Old World species of *Eriocera* [5] the present fly runs to couplet 27, disagreeing with the various indicated characters by the presence of a stigma and in the fact that R_{1+2} is approximately twice as long as R_2.

[5] Ann. & Mag. Nat. Hist. IX 8 (1921) 70–78.

ERIOPTERINI

LIPSOTHRIX TOKUNAGAI sp. nov. Plate 1, fig. 18; Plate 3, fig. 44.

General coloration pale yellow, including the body, halteres, and wings; veins pale yellow.

Male.—Length, about 7 millimeters; wing, 6.

Antennæ broken. Head brownish yellow.

Mesonotum, pleura, and halteres entirely pale yellow. Legs with the coxæ and trochanters pale yellow; femora pale yellow, broken before tips; remainder of legs broken. Wings (Plate 1, fig. 18) entirely pale yellow; veins pale yellow, some of the elements almost invisible in microscopic mounts; macrotrichia brown. Venation: Sc_1 ending just beyond fork of Rs, Sc_2 faint, placed close to its tip; veins R_3 and R_4 extending parallel to one another for most of their length, a little divergent at tips.

Abdomen entirely pale yellow, only the outer dististyle darkened. Male hypopygium (Plate 3, fig. 44) with the outer dististyle, *od,* bearing the usual appressed tooth on inner margin at about two-thirds the length. Interbase, *i,* long and sinuous.

Habitat.—Japan (Honshiu).

Holotype, male, Mount Daisen, Tottori, July 2, 1931 (*Tokunaga*).

It is with great pleasure that I dedicate this striking new *Lipsothrix* to Dr. Masaaki Tokunaga. The present fly is readily told from the other species in eastern Asia by the uniform pale yellow coloration of the body and wings. The other species are from Formosa and the Riukiu Islands, the present record being the first from the major islands of Japan. The name *Electrolabis* Alexander [6] should be placed in the synonymy of *Lipsothrix* and extends the range of the genus back to the Lower Oligocene (Baltic amber).

GONOMYIA (PTILOSTENA) ABJECTA sp. nov. Plate 1, fig. 19; Plate 3, fig. 45.

General coloration gray; basal two segments of antennæ yellow, the remainder black; pleura striped; femora and tibiæ yellow, the tips of the latter, together with the tarsi, black; wings with a strong yellow tinge; stigma small, pale brown; Sc_1 ending about opposite midlength of Rs, Sc_2 before this origin; veins R_{1+2} and R_3 closely approximated at wing margin; male hypopygium with the outer dististyle bifid, each arm terminating in an acute spine; inner dististyle a simple spine; ædeagus without blackening.

Male.—Length, about 4.5 millimeters; wing, 5 to 5.2.

[6] Bernsteinforschungen Heft 2 (1931) 58–59, figs. 68–70.

Female.—Length, about 5.5 to 6 millimeters; wings, 5 to 5.6. Rostrum and palpi brownish black. Antennæ with the scape and pedicel light yellow; flagellum black, the basal segment somewhat paler; flagellar segments elongate to fusiform, the verticils exceeding the segments. Head flesh-colored, the center of the posterior vertex gray.

Pronotum grayish brown medially above, the lateral portions and the anterior lateral pretergites light yellow. Mesonotal præscutum light gray, the humeral and lateral portions restrictedly yellow; posterior sclerites of mesonotum uniformly darkened, gray pruinose. Pleura with the dorsal portion gray pruinose, clearer brown along the ventral margin, the ventral sternopleurite more reddish brown; an obscure yellow longitudinal stripe extending from behind the fore coxæ to beneath the halteres, this sometimes poorly indicated. Halteres pale yellow, the knobs infuscated. Legs with the fore coxæ darkened, the remaining coxæ and all trochanters yellowish testaceous; femora and tibiæ yellow, the latter narrowly darkened at tips; tarsi black. Wings (Plate 1, fig. 19) with a strong yellowish tinge; stigma small, pale brown; veins pale yellowish brown. Venation: Sc_1 ending about opposite midlength of Rs, Sc_2 some distance before origin of Rs; R_{1+2} and R_3 approximated to practically contiguous at margin.

Abdominal tergites blackened, their lateral margins narrowly yellow, in cases, also with the caudal margins narrowly pale; sternites yellow, vaguely darkened medially. Male hypopygium (Plate 3, fig. 45) with the apical lobe of basistyle, *b*, simple, obtusely rounded. Outer dististyle, *od*, bifid, both arms ending in acute black spines. Middle dististyle, *md*, with both arms expanded, the inner shorter, suboval in outline, the margin of the notch of the style blackened. Inner dististyle, *id*, simple, terminating in a blackened spine. Ædeagus, *a*, without blackening, subtended by a narrow flange, at its widest part with about a dozen pale setæ.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*). Allotopotype, female, with the type. Paratopotypes, 4 females; paratype, 1 male, altitude 4,000 feet, July 21, 1931 (*Franck*).

Gonomyia (*Ptilostena*) *abjecta* is quite distinct from the other described regional species of the subgenus in the structure of the male hypopygium, taken in conjunction with the wing pattern and details of venation. In the male hypopy-

gium, especially the entirely pale ædeagus, the fly comes closest to *G.* (*P.*) *shantungensis* Alexander (China and Japan), which has a distinct radial venation and a profoundly divided outer dististyle of the hypopygium. The species *pallens* Alexander and *teranishii* Alexander, both of Japan, have the ædeagus heavily blackened and variously toothed near the apex.

GONOMYIA (LIPOPHLEPS) ANGULIFERA sp. nov. Plate 1, fig. 20; Plate 3, fig. 46.

General coloration dark grayish brown; posterior margin of scutellum obscure yellow; pleura dark, with a silvery longitudinal stripe; halteres pale yellow; femora yellow, with a conspicuous, dark brown, subterminal ring; wings broad, pale brownish, variegated with whitish hyaline areas; Sc short; male hypopygium with the outer dististyle entirely blackened, profoundly bifid at base, the two arms microscopically toothed and roughed at tips.

Male.—Length, about 2.8 millimeters; wing, 3.2.

Rostrum and palpi blackish. Basal segments of antennæ obscure yellow above, darker beneath; flagellum black. Head dark grayish brown.

Anterior lateral pretergites very restrictedly yellow. Mesonotum dark grayish brown, the posterior margin of scutellum obscure yellow; pseudosutural foveæ shiny black. Pleura brownish black, with a single, silvery, longitudinal stripe. Halteres pale yellow, the base of stem narrowly darkened. Legs with the fore coxæ chiefly silvery, remaining coxæ more yellowish, their bases narrowly darkened; trochanters obscure yellow, the fore pair darker; femora yellow, with a conspicuous dark subterminal ring; remainder of legs pale yellow, the terminal tarsal segments darker. Wings (Plate 1, fig. 20) broad, the ground color pale brownish, conspicuously variegated by more-whitish hyaline areas, including a nearly complete crossband before cord, with other smaller clear areas beyond stigma, in cell 1st M_2, and in the outer medial cells; cells Cu and 1st A less evidently variegated by pale areas; stigma pale brown, a little darker than the ground; prearcular and costal regions slightly clearer yellow; veins pale, darker in the clouded areas. Venation: Sc short, Sc_1 ending before origin of Rs, the distance about equal to one-half the length of the latter, Sc_2 not clearly apparent in the unique type but apparently placed close to tip of vein; anterior branch of Rs diverging strongly from

the posterior branch, about one-fourth longer than Rs; cell 1st M_2 closed.

Abdomen chiefly dark brown, the caudal margins of the more-basal segments slightly more yellowish; hypopygium dark. Male hypopygium (Plate 3, fig. 46) with what appears to represent lateral tergal lobes, *9t*, cylindrical, each tipped with a small blackened spine. Outer dististyle, *od*, heavily blackened, profoundly bifid at extreme base, the two arms divergent at about a right angle; basal arm shorter, its apex a little expanded into a microscopically roughened head; outer arm similarly expanded at distal end, the outer margin with a few, small, retrorse spines. Inner dististyle a slender, simple, pale rod, with numerous setæ, including two larger fasciculate setæ at apex. Phallosome, *p*, not in condition to be described or figured in the unique type, consisting of two slender, curved, blackened arms, in addition to a complicated development of the ædeagus.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*).

Gonomyia (*Lipophleps*) *angulifera* is very distinct from all other regional species known to me in the structure of the male hypopygium, especially of the outer dististyle. By Edwards's key to the Oriental species of *Lipophleps*[7] the present fly runs to *subnebulosa* Edwards (Pahang), which is still known only from the female sex. This species has a quite different venation and pattern of the wing.

ORMOSIA LÆVISTYLA sp. nov. Plate 1, fig. 21; Plate 3, fig. 47.

Belongs to the *aculeata* group; large (wing, male, 7.5 millimeters); halteres light yellow; male hypopygium with the outer dististyle smooth, with a rounded basal lobe; inner dististyle obtuse at tip.

Male.—Length, about 6 millimeters; wing, 7.5.

Palpi and antennæ black. Head black, probably pruinose in fresh specimens.

Mesothorax discolored in the unique type, black, presumably gray pruinose in fresh specimens. Halteres pale. Legs with the coxæ concolorous with the thorax; trochanters obscure yellow; remainder of legs broken. Wings (Plate 1, fig. 21)

[7] Journ. Fed. Malay St. Mus. 14 (1928) 104–105.

with the ground color whitish; stigma and narrow seams along cord, Sc_2, tip of R_3, and m infuscated; outer end of cell 2d M_2 less evidently clouded; veins brown; a more-whitish obliterative area across the fork of vein M. Venation: R_2 just beyond fork of R_{2+3+4}; veins R_3 and R_4 slightly upcurved at tips; cell 1st M_2 open; m transverse, meeting the outer section of M_3 at a spurred right angle; m-cu just before fork of M; vein 2d A sinuous.

Abdomen black, pruinose, with numerous white setæ; hypopygium brownish black. Male hypopygium (Plate 3, fig. 47) with the basistyle, *b*, produced at apex into a small chitinized spine, as in the group. Outer dististyle, *od*, smooth, with a flattened, earlike lobule at base. Inner dististyle, *id*, blunt at apex, the distal third with small setulæ.

Habitat.—Japan (Honshiu).

Holotype, male, Kibune, Kyoto-fu, altitude 750 feet, April 20, 1930 (*Tokunaga*).

Ormosia lævistyla is allied to *O. aculeata* Alexander and *O. horiana* Alexander, likewise from Japan, differing especially in the large size and structure of the male hypopygium. The small, obtuse, basal lobe of the outer dististyle is quite different from that found in the two species mentioned, where this lobe is prolonged into acute spines (two smooth spines in *horiana;* a single roughened to spiculose arm in *aculeata*).

ORMOSIA AURICOSTA sp. nov. Plate 1, fig. 22.

General coloration of mesonotal præscutum and scutum reddish brown, the postnotum and pleura abruptly blackened; antennæ chiefly pale; legs yellow, the femora with a scarcely indicated subterminal brown ring; wings infuscated, the costal border conspicuously golden yellow, the cord and apices of the marginal longitudinal veins with narrow seams and spots of darker brown; m-cu more than one-half its length before the fork of M.

Female.—Length, about 4.6 millimeters; wing, 5.

Rostrum and palpi black. Antennæ chiefly pale; flagellar segments subcylindrical, with long conspicuous verticils. Head dark.

Mesonotal præscutum and scutum reddish brown, the scutellum a little darker. Pleura and postnotum blackened. Halteres with the stem pale, knobs broken. Legs with the coxæ

brownish black; trochanters brownish yellow; femora golden yellow, with a narrow, scarcely indicated, brown, subterminal ring; fore femora with an additional pale brown ring at about one-third the length, this ring subequal in width to the subterminal darkening and about one-third as extensive as the yellow medial annulus; tibiæ and basitarsi light yellow, the terminal tarsal segments dark brown. Wings (Plate 1, fig. 22) with the ground color strongly infuscated, the costal region broadly golden yellow; cells C and Sc variegated with darker only at arculus and Sc_2; outer ends of cells Sc_1, R_2, and R_3 with similar yellow marginal areas that are evidenced chiefly by the yellow costal vein; an oblique, more-whitish area across the cord, including the outer end of cell R and the extensive basal portion of the united cell 1st M_2 and M_3; narrow darker seams and spots at ends of longitudinal veins, along cord, and at fork of M_{1+2}; a pale spot before outer end of vein 2d A; axillary margin narrowly pale yellow; veins dark, luteous in the yellow areas. Venation: Sc_1 ending just beyond R_2, Sc_2 about opposite two-fifths the length of Rs; tips of veins R_3 and R_4 slightly upcurved; inner end of cell 2d M_2 almost squarely truncated; m-cu about one-half its length before fork of M; vein 2d A only gently sinuous on distal third.

Abdomen black, the genital shield of ovipositor obscure yellow; cerci powerful, horn-colored, very gently upcurved to their acute tips.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 3,500 feet, August 16, 1931 (*Franck*).

Ormosia auricosta is readily told from other regional allied species by the pattern of the wings and legs. The yellow femora distinguish it from the Himalayan and Chinese species so far described.

ERIOPTERA (ERIOPTERA) JUVENILIS sp. nov. Plate 1, fig. 23.

General coloration of mesonotum light gray, the præscutum with a more-brownish median stripe that is further split on cephalic half by a capillary blackened vitta; antennæ with the basal three flagellar segments partly united into a fusion segment; basal segments of flagellum yellow; knobs of halteres blackened; legs beyond trochanters black; wings broad, light yellow; vein 2d A unusually long and sinuous; abdomen dark brown.

Female.—Length, about 5 millimeters; wing, 5.7.

Rostrum and palpi black. Antennæ with the scape and pedicel dark brown; basal five segments of flagellum light yellow, the terminal segments passing to brown; basal three flagellar segments large and partly fused into a single structure, the succeeding segments distinct; verticils nearly as long as the segments. Head with the center of vertex brownish black, the orbits narrowly light gray.

Pronotum narrowly darkened medially above, yellow on sides. Mesonotal præscutum light gray, with a broad, more brownish gray, median stripe that is delimited laterally by the darkened punctures of the interspaces; a further more-blackened capillary line on cephalic half of sclerite, broadest in front, narrowed to a point about opposite the level of the pseudosutural foveæ; humeral region and lateral margins of præscutum restrictedly pale yellow; posterior sclerites of mesonotum more grayish brown, the postnotal mediotergite even darker. Pluera plumbeous gray, the dorsopleural membrane testaceous-yellow; no trichia on pteropleurite except near extreme dorsocaudal portion. Halteres pale yellow, the knobs and outer end of stem blackened. Legs with the fore coxæ brownish plumbeous, the remaining coxæ a trifle paler; trochanters obscure yellow; remainder of legs black. Wings (Plate 1, fig. 23) broad, clear light yellow, somewhat more obscured beyond cord; stigmal region insensibly darkened; veins deep yellow; macrotrichia pale brown. Venation: M_3 very strongly deflected cephalad at outer end, M_4 and Cu_1 less strongly so; vein 2d A unusually long and sinuous, cell 1st A being strongly widened at midlength.

Abdomen dark brown. Ovipositor with the cerci yellowish horn-color, smooth; hypovalvæ blackened, except for a paler ventral coloration at base.

Habitat.—Japan (Honshiu).

Holotype, female, Shirouma-dake, Japanese Alps, August 8, 1931 (*Machida*).

Erioptera (*Erioptera*) *juvenilis* is most nearly allied to *E.* (*E.*) *horii* Alexander and *E.* (*E.*) *orbitalis* Alexander, both of northern Japan, differing very evidently in the black legs, the broad wings, and the details of the body coloration.

ERIOPTERA (ERIOPTERA) LEUCOSTICTA sp. nov. Plate 1, fig. 24; Plate 3, fig. 48.

Belongs to the *alboguttata* group; general coloration of mesonotum yellowish brown; pleura obscure yellow, striped longi-

tudinally with dark brown; wings brown, with a conspicuous white-spotted pattern, including a large area in outer ends of both anal cells, basad of the spot at end of vein 2d A; male hypopygium with the outer dististyle without lateral spine; inner dististyle with a linear groove or incision at apex; gonapophyses terminating in long slender blackened points, the concave portion of these structures densely setiferous.

Male.—Length, about 3 millimeters; wing, 3.5.

Rostrum brownish black; palpi black. Antennæ with the scape and pedicel black, the flagellum more brownish black, with long, conspicuous verticils. Head light yellow.

Pronotum brownish yellow. Anterior lateral pretergites whitish. Mesonotum brown laterally, the disk of præscutum and the scutal lobes more yellowish brown; scutellum and postnotal mediotergite more infuscated. Pleura obscure yellow, longitudinally striped with dark brown, the dorsal stripe narrow, the ventral one broader, including the ventral sternopleurite and meral regions. Halteres pale yellow, with yellow setæ. Legs with the coxæ dark brown; trochanters obscure yellow, their tips weakly darkened; femora deep reddish yellow; tibiæ and tarsi light golden yellow. Wings (Plate 1, fig. 24) brown, with a conspicuous white-spotted pattern as in the group, including the following areas: Origin of Rs; marginal series at ends of all longitudinal veins with the exception of R_5, that at M_{1+2} very small; areas becoming progressively larger backwards from the wing tip, that at 2d A again reduced in size; a major white area occupies cells 1st A and 2d A at the level of the origin of Rs; a continuous white band along cord; a spot at fork of M_{3+4}; basal portion of wing more yellowish brown, the posterior arcular region strongly infuscated; veins yellow, almost invisible in the white areas. Venation: Vein 2d A rather strongly sinuous.

Abdomen brownish black, the hypopygium somewhat brighter. Male hypopygium (Plate 3, fig. 48) much as in *alboguttata*. Outer dististyle, *od*, without lateral spine at base of club, as in *paivai*. Inner dististyle, *id*, with the apex split by a deep linear groove, the terminal spine blackened; surface of style with only one or two punctures. Gonapophyses, *g*, with long, slender, black, apical points, the concave face of the structures with numerous setæ.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*).

Erioptera (*Erioptera*) *leucosticta* is most nearly allied to *E.* (*E.*) *alboguttata* Edwards (Formosa) and *E.* (*E.*) *paivai* Alexander (eastern Himalayas), differing from both in the structure of the male hypopygium and in the presence of an added white spot in the outer ends of both anal cells basad of the one at end of vein 2d A. In *alboguttata* this region of the wing is vaguely paler but without a clearly defined white area similar to those elsewhere on the wing surface.

ILLUSTRATIONS

[Legend: *a*, Ædeagus; *b*, basistyle; *d*, dististyle; *dd*, dorsal dististyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *mb*, ventro-mesal lobe of basistyle, detail; *md*, middle dististyle; *od*, outer dististyle; *p*, phallosome; *s*, sternite; *t*, tergite; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Trichocera reticulata* sp. nov., venation.
2. *Tipula machidai* sp. nov., venation.
3. *Tipula (Formotipula) luteicorporis* sp. nov., venation.
4. *Limonia (Limonia) lackschewitziana* sp. nov., venation.
5. *Limonia (Limonia) commixta* sp. nov., venation.
6. *Limonia (Dicranomyia) shinanoensis* sp. nov., venation.
7. *Limonia (Dicranomyia) trispinula* sp. nov., venation.
8. *Limonia (Rhipidia) garrula* sp. nov., venation.
9. *Limonia (Geranomyia) bifurcula* sp. nov., venation.
10. *Antocha (Antocha) pallidella* sp. nov., venation.
11. *Antocha (Antocha) setigera* sp. nov., venation.
12. *Pedicia brachycera* sp. nov., venation.
13. *Pedicia subtransversa* sp. nov., venation.
14. *Dicranota (Dicranota) nippoalpina* sp. nov., venation.
15. *Dicranota (Rhaphidolabis) sinoalpina* sp. nov., venation.
16. *Troglophila szechwanensis* sp. nov., venation.
17. *Eriocera (Eriocera) hemicera* sp. nov., venation.
18. *Lipsothrix tokunagai* sp. nov., venation.
19. *Gonomyia (Ptilostena) abjecta* sp. nov., venation.
20. *Gonomyia (Lipophleps) angulifera* sp. nov., venation.
21. *Ormosia lævistyla* sp. nov., venation.
22. *Ormosia auricosta* sp. nov., venation.
23. *Erioptera (Erioptera) juvenilis* sp. nov., venation.
24. *Erioptera (Erioptera) leucosticta* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula machidai* sp. nov., male hypopygium, lateral aspect.
26. *Tipula machidai* sp. nov., male hypopygium, ninth tergite.
27. *Tipula machidai* sp. nov., male hypopygium, ninth sternite.
28. *Tipula machidai* sp. nov., male hypopygium, dististyles.
29. *Tipula (Formotipula) luteicorporis* sp. nov., male hypopygium, lateral aspect.
30. *Tipula (Formotipula) luteicorporis* sp. nov., male hypopygium, ninth tergite.
31. *Tipula (Formotipula) luteicorporis* sp. nov., male hypopygium, eighth sternite.
32. *Limonia (Limonia) lackschewitziana* sp. nov., male hypopygium.
33. *Limonia (Limonia) commixta* sp. nov., male hypopygium.
34. *Limonia (Dicranomyia) trispinula* sp. nov., male hypopygium.
35. *Limonia (Rhipidia) garrula* sp. nov., male hypopygium.
36. *Limonia (Geranomyia) bifurcula* sp. nov., male hypopygium.

PLATE 3

FIG. 37. *Antocha* (*Antocha*) *pallidella* sp. nov., male hypopygium.
38. *Antocha* (*Antocha*) *setigera* sp. nov., male hypopygium.
39. *Pedicia daimio* (Matsumura), antennal flagellum, female.
40. *Pedicia brachycera* sp. nov., antennal flagellum, female.
41. *Pedicia subtransversa* sp. nov., male hypopygium.
42. *Dicranota* (*Dicranota*) *nippoalpina* sp. nov., male hypopygium.
43. *Dicranota* (*Rhaphidolabis*) *sinoalpina* sp. nov., male hypopygium.
44. *Lipsothrix tokunagai* sp. nov., male hypopygium.
45. *Gonomyia* (*Ptilostena*) *abjecta* sp. nov., male hypopygium.
46. *Gonomyia* (*Lipophleps*) *angulifera* sp. nov., male hypopygium.
47. *Ormosia lævistyla* sp. nov., male hypopygium.
48. *Erioptera* (*Erioptera*) *leucosticta* sp. nov., male hypopygium.

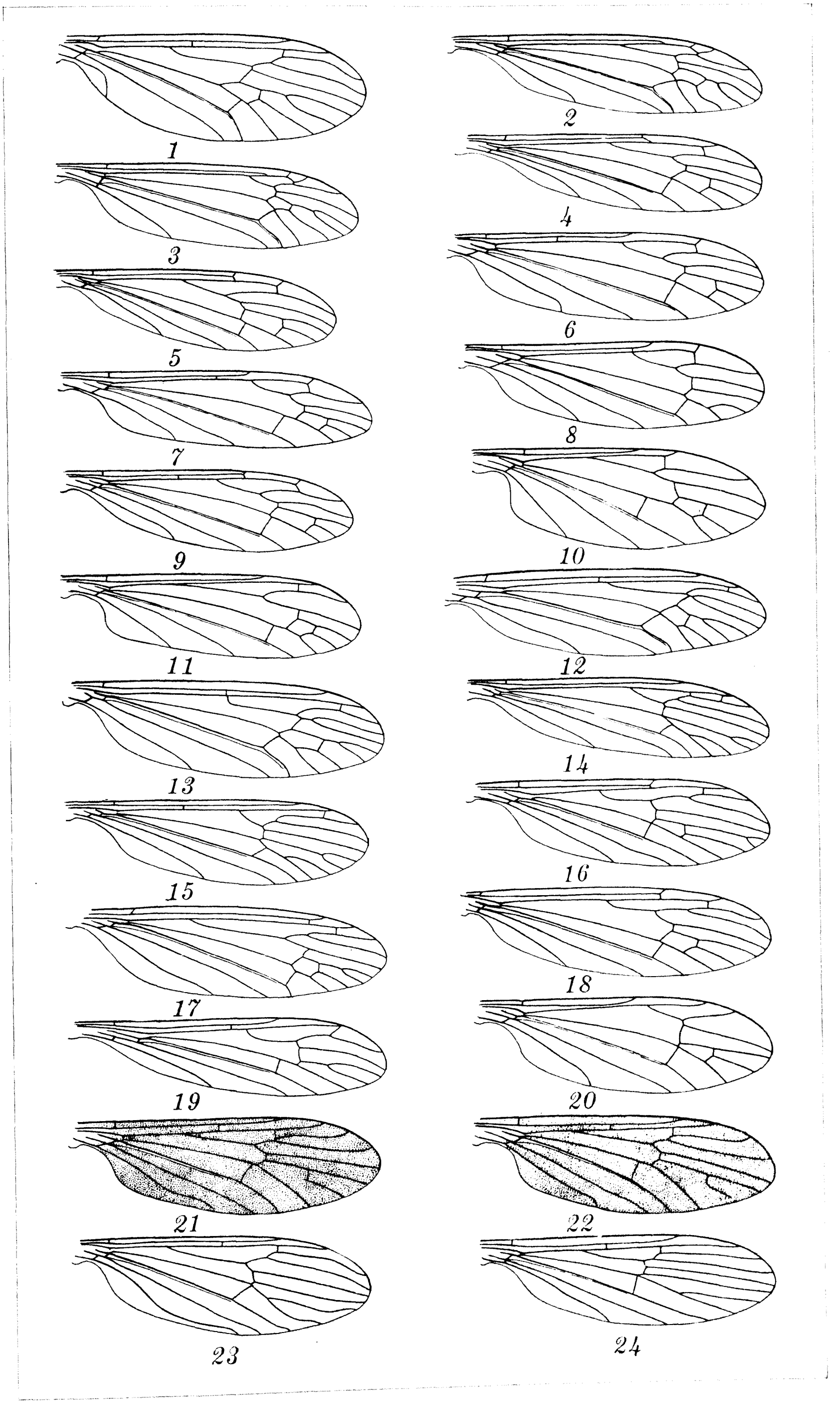
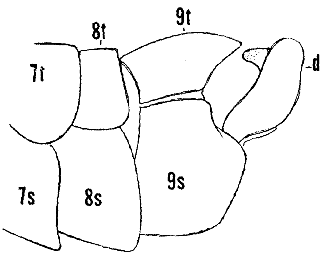


PLATE 1.



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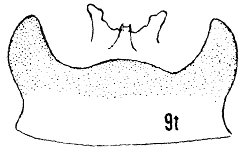

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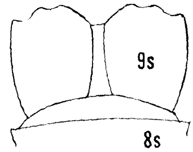

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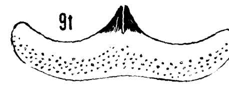

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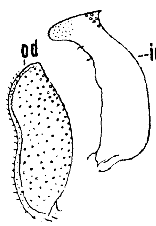

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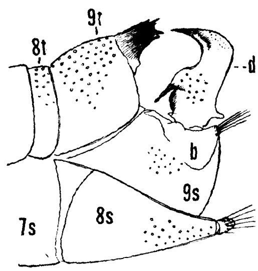

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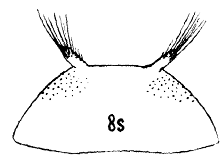

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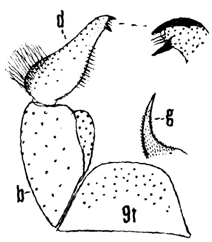

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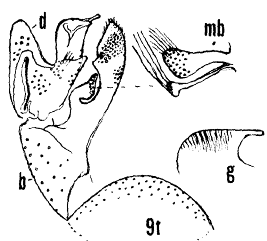

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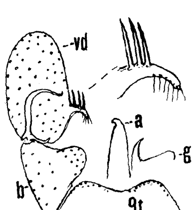

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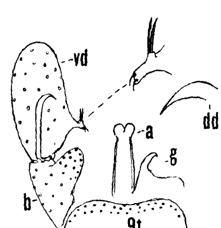

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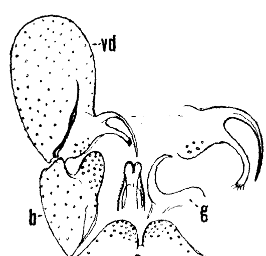

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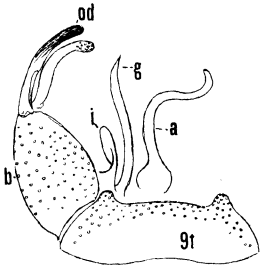
PLATE 2.



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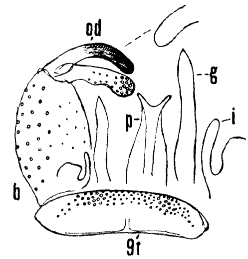

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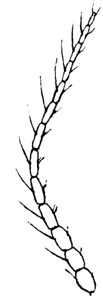

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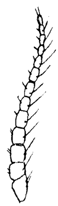

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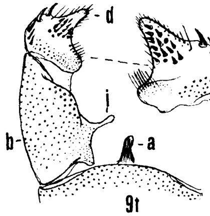

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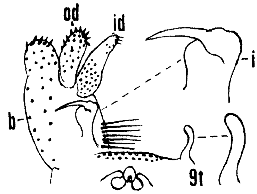

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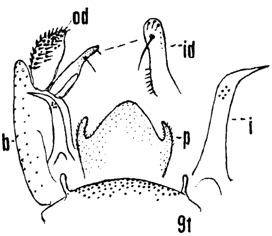

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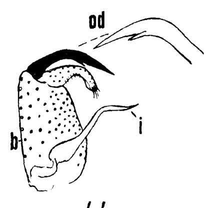

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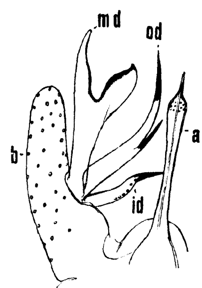

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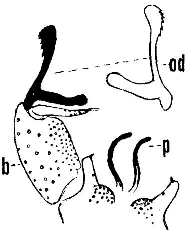

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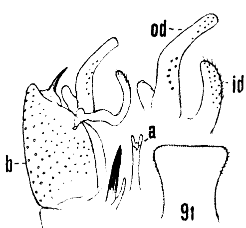

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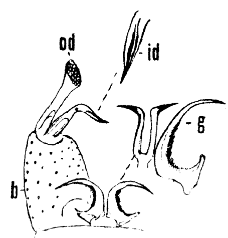

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PLATE 3.

EINE ERWEITERTE BESTIMMUNGSTABELLE DES SUBGENUS SUNIOPS UNTER DEM GENUS EUOPS (COLEOPTERA; CURCULIONIDÆ)

39. BEITRAG ZUR KENNTNIS DER CURCULIONIDEN

Von Eduard Voss

Berlin-Charlottenburg, Deutschland

EINE TEXT FIGUR

Die Bestimmung der *Euops*-Arten ist zum Teil recht schwierig, und schon die Abtrennung mancher Arten stösst oft auf erhebliche Schwierigkeiten, weil wichtige Merkmale zur Unterscheidung nur beim Männchen aufzufinden oder hier wenigstens besonders auffällig ausgebildet sind. Es war daher ein glücklicher Umstand, dass sich im Material C. F. Baker's, besonders aber in der vom Zoologischen Museum Berlin erworbenen reichen Moserschen Sammlung manches die bisherige Kenntnis der

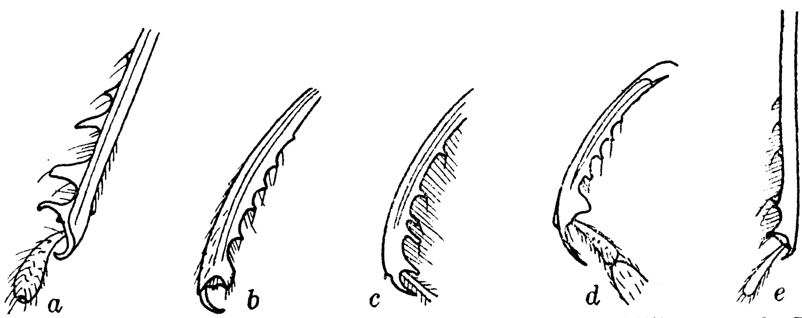

Fig. 1. Aussenzähnelung der männlichen Vordertibia. *a, Euops viridifusca* m.; *b, E. jucunda* sp. nov.; *c, E. dentata* m.; *d, E. cuprea* sp. nov.; *e, E. parvula* sp. nov.

Untergattung *Suniops* erweiternde Neue fand. Die Arten dieser Untergattung sind an den gezähnten Schenkeln von den übrigen Untergattungen leicht zu unterscheiden, doch finden sich auf den Philippinen zwei, allerdings recht markante, Arten, die diese Auszeichnung nicht aufweisen, aber doch unter diese Untergattung gestellt werden müssen. Eine einfache Beschreibung der neu erkannten Arten schien mir nicht angezeigt, es wurde daher eine grundsätzliche Überarbeitung dieser Gruppe vorgenommen.

Schon in früheren Arbeiten konnte ein Merkmal herangezogen werden, das den Männchen einiger Arten eigen ist und leicht übersehen werden kann. Und zwar handelt es sich um eine Aussenzähnelung der Vordertibien neben den fast stets vorhandenen, gereiht angeordneten Höckerchen oder Zähnchen der Innenseite. Eine Wiedergabe der Unterschiede in der Zähnelung durch das Wort allein lässt vermutlich die Erkennung nicht so einwandfrei zu, wie eine bildliche Darstellung. Aus diesem Grunde wurden einige Abbildungen eingefügt, die gleichzeitig noch Unterscheidungsmerkmale hinsichtlich der Art der Behaarung beziehungsweise, Bewimperung erkennen lassen.

*a*¹. Schenkel ohne Zähnchen; Vorderschenkel in beiden Geschlechtern sehr kräftig, so stark oder fast so stark wie der Kopf breit. Vordertibien des Männchens aussen mit langen Zähnen oder Dornen bewerht: 1. Gruppe.

*b*¹. Zwischenräume der Flügeldecken so breit wie die Punktstreifen, leicht gewölbt, die Punktierung ziemlich kräftig, dicht, querrunzlig verlaufen. Kopf fein und mässig dicht punktiert, zwischen den Punkten ebenso wie an den Seiten des grob und teilweise runzlig verlaufen punktierten Halsschilds, der Körperunterseite und an den Schenkeln sehr fein und dicht punktiertchagriniert. Fühler kurz, nur das 4. Geisselglied und das 1. Glied der Fühlerkeule etwas länger als breit. Die Vordertibien des Männchens stark gebogen, der äussere Zahn an der Spitze lang, schwach gebogen, der zweite breit und zweispitzig, der 3. Zahn kleiner. Färbung hell bronzeglänzend; das Abdomen des Männchens in der Mitte kurz abstehend behaart. Länge 3.3 mm. Philippinen, Nord-Luzon, Balbalasan (*Boettcher*), März, 1918; Mus. Berlin (coll. Moser).
E. moseri sp. nov.

*b*². Flügeldecken stark grubig punktiert, die Punktgruben wabenartig gegeneinander versetzt, sodass die Zwischenräume sehr schmal gewellt ausgebildet sind; letztere nur mit feinen vereinzelten Punkten besetzt. Die übrige Körperskulptur ähnlich der vorhergehenden Art. Die drei ersten äusseren Zähne mit Ausnahme des zweiten, an der Spitze abgestutzten Zahnes schlank, lang und spitz, die folgenden klein, spitzig. Färbung dunkelbraun; Unterseite mit Ausnahme der Beine metallischgrün und auch der Kopf, die Seiten des Halsschilds und die Flügeldecken in den vertieften Stellen mit metallischgrünem Anflug. Länge 4 mm. Philippinen, Luzon, Benguet, Santo Tomas; Panay, Mount Macosolon; Mindanao, Dapitan .... *E. viridifusca* m.

*a*². Schenkel mit spitzem Zähnchen bewehrt: 2. Gruppe.

*b*¹. Halsschild auf der Scheibe kräftig querriefig skulptiert.

*c*¹. Hinter dem Vorderrand des Halsschilds sind die Querriefen beiderseits der Mitte kreiselartig angeordnet, sodass Neigung zu einer pustelartigen Aufwölbung dieser Partie besteht. Die Punkte der Streifen auf den Flügeldecken sind scharf querviereckig ausgebildet, die Zwischenräume sehr schmal, kielartig. Pygi-

dium ziemlich kräftig und sehr dicht punktiert. Färbung schwarzbraun; Vorderrand der Hinterbrust, basale Hälfte der Mittel- und Hinterschenkel sowie die Mitte des Abdomens metallischgrün; Schildchen kupferrot, glänzend. Länge, Weibchen, 4 mm. Philippinen, Mindanao, Butuan (*Baker*). In meiner Sammlung .... *E. turbaticollis* sp. nov.

c^2. Das Halsschild auch vorn einfach querriefig skulptiert.

d^1. Körperform länglicher, gestreckter; Flügeldecken etwa ein und ein Viertel bis anderthalbmal so lang wie breit.

e^1. Die apikale Partie der Flügeldecken einfach, normal verrundet, der 3. und 4. Zwischenraum nicht vorgezogen.

f^1. Flügeldecken grob punktiert, die Zwischenräume grobrunzlig skulptiert, gewölbt, so breit wie die Streifen. Vorderschenkel kräftig keulenförmig. Färbung schwarz, Oberseite mit Erzglanz, unterseits metallisch glänzend; Schildchen kupferrot; Schenkel hellrot, Tibien und Tarsen rot mit bläulichem Schein. Länge, 3.5 bis 4.2 mm. Philippinen, Luzon, Benguet, Baguio, Santo Tomas. *E. elongata* m.

f^2. Punktstreifen der Flügeldecken fein; Zwischenräume flach und viel breiter als die Punktstreifen, die ganzen Decken gleichmässig fein querrunzlig skulptiert, die Querrunzlung kräftiger als diejenige des Halsschilds. Kopf fein und dicht punktiert, der Untergrund ebenso wie die Zwischenstege der seitlichen groben Punktierung des Halsschilds sehr fein und sehr dicht matt punktiert. Erstes Geisselglied kräftig, oval, etwas länger als breit; Glied 2 bis 6 an Länge wenig verschieden, länger als breit; 7. Glied quer. Erstes Glied der Fühlerkeule so lang wie breit; 2. und 3. Glied quer; das Endglied kurz kegelförmig. Färbung schwarz; oberseite nur mit schwachem Erzschein, Unterseite stärker metallisch glänzend; Schildchen leuchtend grün. Länge, Weibchen, 3.5 mm. Philippinen, Nord-Luzon, Mount Data (*Boettcher*), März, 1917. Mus. Berlin (coll. Moser) .... *E. cribraria* sp. nov.

e^2. An der Spitze der Flügeldecken ist der 3. und 4. Zwischenraum vorgezogen, sodass die Decken bei der Schrägaufsicht ausgehöhlt erscheinen; da die Zwischenräume hinten stark gewölbt sind, ist der Deckenabsturz scheinbar gekerbt. Kopf fein und weitläufig punktiert, mit sehr feiner, gedrängter Zwischenpunktierung, die auch auf den Zwischenstegen der seitlichen, grubenförmigen Halsschildpunktierung festzustellen ist. Die Punktgruben sind seitlich nur im Übergang zur Querriefelung runzlig verlaufen. Die vier ersten Geisselglieder länger als breit; das erste kräftig, oval; 5. bis 7. Glied nur so lang wie breit. Erstes und 2. Glied der Fühlerkeule so lang wie breit; 3. Glied quer. Punktstreifen der Flügeldecken kräftig, die Punkte etwas wabenartig gegeneinander versetzt; die Zwischenräume kommen nur hinten zur Entwicklung. Färbung schwarz mit Erzglanz;

Schildchen dunkelgrün. Philippinen, Nord-Luzon, Balbalasan (*Boettcher*), März, 1918. Mus. Berlin (coll. Moser). *E. apicalis* sp. nov.

d[2]. Körper von normaler Gestalt, die Flügeldecken kaum länger als breit, durchaus regelmässig punktiert gestreift.

e[1]. Zwischenräume der Flügeldecken flach, jedoch nach innen, zur Naht hin, schräg abfallend geneigt; die Punktstreifen innen vom Zwischenraum scharf begrenzt, nach aussen frei auslaufend, (die Punkte der Streifen gewissermassen schräg von der Seite eingestochen).

f[1]. Grössere Art, über 4 mm gross. Zwischenräume der Flügeldecken kräftiger querrunzlig verlaufen skulptiert, dazwischen feiner unregelmässig punktiert; Zwischenräume breiter als die Streifen. Vordertibien des Männchens aussen mit kräftigeren Zähnen bewehrt. Färbung metallisch grün, Tibien, Tarsen und zum Teil die Vorderschenkel stahlblau; Halsschild und Flügeldecken dunkler grün, letztere bisweilen von der Basis aus purpurrot übergossen. Philippinen, Mindoro, Calavite; Luzon, Benguet, Santo Tomas .... *E. schultzei* m.

f[2]. Tiere höchstens 3.5 mm lang.

g[1]. Pygidium kräftig und sehr dicht, etwas runzlig verlaufen punktiert. Halsschild mässig stark und gleichmässig gerundet nach vorn verschmälert; in der Querriefelung sind die Punkte noch sichtbar. Färbung grünlichblau. China, Tonkin .... *E. blanda* m.

g[2]. Pygidium feiner, nie runzlig punktiert.

h[1]. Schildchen hinten gerade abgestutzt oder schwach konvex gerundet.

i[1]. Kopf hochglänzend und unpunktiert. Vordertibien des Weibchens breit und an der Spitze stark einwärts gebogen. Halsschild auf der Scheibe vorn fein und dicht punktiert; Zwischenräume der Flügeldecken fein und dicht ein- bis zweireihig punktiert. Unterseits metallischgrün, oben blau gefärbt. Sumatra, Sibolangit .... *E. gratiosa* m.

i[2]. Kopf meist weniger glänzend, mehr oder weniger stark punktiert, oft zwischen den Punkten mit sehr feiner und dichter, mattierender Grundpunktierung.

j[1]. Tier hochglänzend, die Zwischenräume schmal rippenartig erhaben. Färbung metallischgrün, Flügeldecken teilweise blau, Fühler, Tibien und Tarsen dunkelbraun. Celebes .... *E. plicata* Pasc.

j[2]. Tiere weniger glänzend, oft matt; die Zwischenräume nicht hochglänzend, kielartig erhaben.

k[1]. Tibien des Männchens aussen vor der Spitze mit einigen entfernt stehenden langen Zähnen bewehrt.

l[1]. Vordertibien des Männchens an der Spitze mit kräftigem, breitem, abgestutztem Lappen, dahinter reihig gezähnt. Halsschild seitlich

kräftig gerundet, Vorderrand mässig verschmälert, kräftig querriefig ohne Zwischenpunktierung.

m [1]. Zwischenräume kräftiger quergerunzelt, an der Aussenkante dicht einreihig punktiert. Halsschild zur Basis weniger verschmälert. Rüssel doppelt so lang wie breit. Kopf ohne kräftigere Punkte, nur mit sehr feiner, matter Grundpunktierung. Vordertibien des Männchens an der Spitze aussen mit einem breiter abgestutzten Lappen. Länge 3 bis 3.5 mm.

n [1]. Unterseite metallischgrün, Halsschild oberseits bräunlich olivgrün, Basis der Flügeldecken kupferrot; Schildchen grün; Färbung im übrigen schwarzblau. Philippinen, Mindoro, Mount Calavite (*W. Schultze*); Mindanao, Davao (*Baker, 6787*). In meiner Sammlung, United States National Museum.

E. jucunda sp. nov.

n [2]. Färbung schwarzblau, Vorderhüften und die basale Hälfte der Hinterschenkel grün. Nord-Luzon Balbalan; Butac (*Boettcher*), Januar, 1917. Mus. Berlin (coll. Moser).

E. jucunda forma *obscura* f. nov.

m [2]. Zwischenräume nur sehr schwach querrunzlig, glänzend, fein entfernt stehend einreihig punktiert. Halsschild zur Basis mehr verschmälert, seitlich kräftig gerundet. Kopf glänzend, mit feinen Punkten weitläufig besetzt. Vordertibien des Männchens vor der Spitze mit mehr zugerundetem Lappen versehen. Rüssel kurz, höchstens anderthalbmal so lang wie breit. Färbung einfarbig kupferglänzend. Länge 2.5 mm. Philippinen, Nord-Luzon, Cabugao (*Boettcher*) Februar, 1918. Mus. Berlin; in meiner Sammlung.................. *E. cuprea* sp. nov.

l [2]. Vordertibien des Männchens aussen an der Spitze in einen einfachen Stachel ausgezogen, dahinter weitläufiger kräftig gezähnt.

m [1]. Die Vordertibien des Männchens sind aussen ziemlich lang und dicht bewimpert, die Wimperhaare doppelt so lang wie die Zähne hoch. Vordertibien des Männchens mit vier langen Zähnen und einem kürzeren Höcker. Halsschild viel breiter als lang, der Vorderrand nur halb so breit wie das Halsschild an der Basis. Punktstreifen

der Flügeldecken stark; Zwischenräume viel schmaler als die Streifen, fein und dicht punktiert. Färbung unterseits metallischgrün, Oberseite schwarzbraun bis schwarz; Schildchen und die Basis der Flügeldecken grün. Philippinen, Luzon, Mount Maquiling; Leyte, Santa Cruz (*Boettcher*), Oktober, 1915 .... *E. dentata* m.

m[2]. Vordertibien des Männchens aussen mit einem langen Dorn an der Spitze, einem Doppelhöcker und drei feineren Kerbzähnen bewehrt. Kopf sehr fein chagriniert, ohne sichtbare Punkte. Halsschild ziemlich gleichmässig gerundet, der Vorderrand nur wenig schmaler als die Basis. Punktstreifen feiner, die Zwischenräume etwas schmaler als die Streifen, fein querrunzlig. Färbung unterseits metallischgrün, oberseits dunkelblau; Schildchen, Schultern und Basis der Flügeldecken grün. Länge 2.2 mm. Philippinen, Mindoro, Mangarin (*Boettcher*) November, 1917. Mus. Berlin (coll. Moser), Weibchen; in meiner Sammlung, Männchen............ *E. parvula* sp. nov.

k[2]. Vordertibien des Männchens vom apikalen Zahn bis über die Mitte hinaus gleichmässig abnehmend gehöckert; lang und gleichmässig gebogen. Färbung schwarz, teilweise grün metallisch überlaufen; Fühler pechbraun; Flügeldecken bis auf die Basis und Schultern blau. Batchian, Sula .... *E. ærosa* Pasc.

Eine Form mit gleichmässiger gezähnten Tibien, sonst kaum verschieden. Philippinen, Mindanao, Momungan (*Boettcher*), Februar, 1915. Mus. Berlin (coll. Moser).
E. ærosa forma *mindanaoensis* f. nov.

k[3]. Vordertibien des Männchens aussen nur wenig oder gar nicht stärker als die innere Leiste gezähnt.

l[1]. Kopf fein querrissig oder punktiert mattiert, ohne erkennbare eingestochene Punkte. Halsschild vor der Basis breiter als an der Wurzel.

m[1]. Punktstreifen kräftig, Zwischenräume sehr schmal. Vordertibien des Männchens gleichmässig gebogen mit deutlich sichtbarer kräftiger Aussenzähnelung. Färbung metallischgrün; die Flügeldecken mit Ausnahme der Basis und des Schildchens schwarzbraun bis schwarzblau gefärbt; Fühler pechbraun. Philippinen, Luzon, Mount Maquiling, Mount Banahao, Mount

Bulusan, Los Baños; Mindanao, Butuan, Surigao; Mindoro, Mangarin.... *E. boviei* m.

m[2]. Punktstreifen feiner, die Zwischenräume fein querrunzlig skulptiert, zwischen den Runzeln mässig dicht einreihig punktiert. Vordertibien des Männchens nur im apikalen Drittel kräftig gebogen, ohne erkennbare Aussenzähnelung, erheblich schlanker als bei der vorhergehenden Art. Die grösste Breite des Halsschilds liegt kurz vor der Basis, nach vorn ist es stark verjüngt. Färbung unterseits metallischgrün, oben kupferglänzend; Beine und Fühler gelbrot, die Schenkel jedoch mit grünmetallischem Schein. Länge 2.5 mm. Philippinen, Macba (*Boettcher*), Januar, 1917. In meiner Sammlung................ *E. cupripennis* sp. nov.

l[2]. Kopf mit deutlich eingestochenen Punkten.

m[1]. Punktstreifen der Flügeldecken kräftig; Zwischenräume sehr schmal.

n[1]. Halsschild an der Basis kräftig verschmälert; Pygidium weniger dicht punktiert. Vordertibien des Männchens länger, gebogen. Kopf und die Zwischenstege der Halsschild-Punktierung mit feiner, sehr dichter Grundpunktierung. Rüssel etwa anderthalbmal so lang wie breit; Fühler vor der Basis eingelenkt. Schaftglied länglich oval, fast doppelt so lang wie breit; 1. Geisselglied gut halb so lang wie das Schaftglied; 2. bis 4. Glied wenig kürzer als das 1. Glied; 5. Glied noch länger als breit; 6. und 7. Glied so lang wie breit. Erstes und 2. Glied der Fühlerkeule so lang wie breit. Färbung schwarzbraun, Fühlergeissel, bisweilen einschliesslich der Keule, und die Tarsen rotgelb; Basis der Decken, Schildchen und Pygidium grünmetallisch. Philippinen, Siargao, Dapa Calundag; Süd-Luzon, Mount Maquiling; Samar, Catbalogan; Polillo; Mindanao, Momungan, Butuan (*Boettcher*), Februar, 1911, April, August und Oktober 1915, 1916. Mus. Berlin, United States National Museum; in meiner Sammlung.

E. rufitarsis sp. nov.

Zuweilen die Unterseite und die Punkte des 3. bis 5. Streifens metallischgrün. Länge 2.7 bis 3 mm.

E. rufitarsis forma *viridisticta* f. nov.

Färbung tiefblau, Tarsen dunkler braun. Mindanao, Port Banga (*Boettcher*), Januar, 1915.

E. rufitarsis forma *cyanea* f. nov.[1]

n[2]. Halsschild an der Basis nicht verschmälert, sondern von hier gleichmässig gerundet nach vorn verjüngt; in den Querriefen des Halsschilds sind die Punkte deutlich erkennbar. Zwischenräume der Flügeldecken breiter, schwächer gerunzelt. Pygidium sehr dicht punktiert. Vordertibien des Männchens gerade, ähnlich den weiblichen Tibien gebildet, doch schlanker; Aussenzähnelung sehr fein bis zu einer unvermittelten Verschmälerung der Tibien im basalen Drittel durchgeführt. Färbung metallischgrün, die Flügeldecken leicht bläulich überhaucht.

Philippinen, Luzon, Atimonan (*Boettcher*), August, 1915; Tayabas, Nueva Ecija, Mount Caraballo, Los Baños.

E. willemoesi Baer.

m[2]. Punktstreifen viel feiner; Zwischenräume breiter und sehr fein, matt skulptiert. Pygidium weniger dicht punktiert; Halsschild seitlich stärker gerundet nach vorn verschmälert als bei *willemoesi* Baer. Vordertibien des Männchens aussen etwas stärker gezähnt. Philippinen, Palawan, Binaluan, November und Dezember, 1913; Mindanao, Mangarin (*Boettcher*), November, 1917; Luzon. In meiner Sammlung, Mus. Berlin, Hamburg.

n[1]. Färbung metallischgrün.... *E. palawana* m.

n[2]. Färbung der Flügeldecken mit Ausnahme der Basis bläulich schwarz.

E. palawana forma *tristicula* f. nov.

n[3]. Färbung tiefblau, Flügeldecken mit leichtem violetten Schein. Mindanao, Momungan (*Boettcher*), August, 1915. Mus. Berlin (coll. Moser).

E. palawana forma *azurea* f. nov.

h[2]. Schildchen hinten konkav, dreieckig ausgeschnitten. Punktstreifen kräftig; Zwischenräume sehr schmal.

[1] Leider liegt nur ein Weibchen vor. Kopf-, Halsschild- und Flügeldeckenskulptur stimmt mit der Nominatform überein, sodass anzunehmen ist, dass es sich um eine Rasse des *rufitarsis* handelt.

Färbung bräunlich-schwarz, bisweilen unten mit grünem oder erzfarbenem Glanz, zuweilen das Schildchen grün und Kopf und Halsschild purpurfarben. Sumatra, Borneo, Penang .... *E. scutellaris* m.

*e*². Zwischenräume der Flügeldecken flach oder gewölbt, die Punkte nicht schräg oder nicht erkennbar schräg eingestochen.

*f*¹. Zwischenräume flach, fein und dicht querrunzlig skulptiert, viel breiter als die Punktstreifen. Halsschild quer, an der Basis nicht verschmälert und von hier nach vorn nur schwach gerundet verschmälert. Kopf nur sehr fein und dicht mattiert punktiert, oben ohne grössere Punkte, nur seitlich dichter punktiert. Färbung kupferfarben, die Flügeldecken dunkler kupferfarben; Schildchen grün; Beine rotbraun mit Kupferglanz; Fühlergeissel rötlich. Länge 2.8 mm. Philippinen, Luzon, Trinidad, in 4000 Fuss Höhe (ex coll. Heyne); Haight's Place (*Boettcher*), März, 1917. In meiner Sammlung, Mus. Berlin (coll. Moser) .... *E. fuscocuprea* sp. nov.

*f*². Zwischenräume der Flügeldecken leicht gewölbt.

*g*¹. Vordertibien des Männchens von der Mitte ab stark einwärts gebogen, aussen besonders vor der Mittelpartie fein gezähnt und von hier aus bis zur Spitze länger dicht bewimpert. Punktstreifen kräftiger als bei der folgenden Art. Färbung grünlich metallisch. Länge 2.2 bis 2.6 mm. Philippinen, Luzon, Imugan (*Boettcher*), Juni, 1917. Mus. Berlin (coll. Moser); in meiner Sammlung .... *E. viridula* sp. nov.

*g*². Vordertibien des Männchens nur im apikalen Drittel leicht einwärts gebogen, aussen gleichmässig fein gekerbt; jeder Höcker trägt ein Härchen, zwischendurch mit nur vereinzelten Härchen besetzt. Zwischenräume breiter als die Streifen, fein querrunzlig und zwischendurch vereinzelt punktiert. Färbung der Flügeldecken mehr hellkupferfarben bis messingglänzend. Philippinen, Nord-Luzon, Balbalasan (*Boettcher*), Januar, 1917; Benguet, Santo Tomas. Mus. Berlin (coll. Moser); in meiner Sammlung. .... *E. semicuprea* m.

*b*². Halsschild einfach punktiert, nicht oder nur schwach querwellig skulptiert; seitlich meist kräftiger punktiert.

*c*¹. Zwischen der Punktierung ist der Untergrund des Halsschilds sehr fein und dicht querrissig grundiert.

*d*¹. Punktstreifen etwas feiner und die Zwischenräume schräg nach innen abfallend, fein einreihig punktiert. Fühlerkeule rötlich. Färbung pechbraun bis schwarz; unterseits, die Seiten des Halsschilds, Schultern und Schildchen grün. Banguey Inseln, Borneo, Philippinen .... *E. anceps* m.

*d*². Punktstreifen etwas kräftiger; Zwischenräume so breit wie die Streifen, gewölbt, etwas versetzt punktiert. Fühler pechschwarz. Färbung schwarz mit violettem oder bläulichem

Schein, Flügeldecken blau, Beine pechbraun mit blauem und teilweise grünem Schein; Rüssel, Vorderhüften und Basis der Decken grün. Ceram .... *E. violacea* Pasc.

c^2. Der Untergrund des Halsschilds ist glatt und glänzend, nur von vereinzelten Querfurchen unterbrochen. Punktierung besonders nach den Seiten zu kräftiger und dichter. Zwischenräume der Flügeldecken breit und flach; Punkte der Streifen getrennt. Färbung tiefblau oder grünlichblau; Rüssel, Fühler, Tibien und Tarsen schwarz. Philippinen, Mindanao, Surigao, Mai und August, 1915; Siargao, Dapa, Oktober, 1916, Caluntug, Juli, 1916; Leyte, Santa Cruz, Oktober, 1915; Luzon, Mount Banahao (*Boettcher*), April, 1914; Los Baños (*Baker*).... *E. cyanella* m.

ILLUSTRATIONS

Text Figur 1. Aussenzähnelung der männlichen Vordertibia. *a*, *Euops viridifusca* m.; *b*, *E. jucunda* sp. nov.; *c*, *E. dentata* m.; *d*, *E. cuprea* sp. nov.; *e*, *E. parvula* sp. nov.

CERTAIN FERNS IN SIR JAMES SMITH'S HERBARIUM

By A. H. G. ALSTON

Of the British Museum (Natural History), London

ONE PLATE

1. DAVALLIA PECTINATA Sm.

Dr. E. B. Copeland, in a recent letter, drew my attention to the fact that there were probably two species included under this name, and accordingly I consulted Smith's herbarium.

Sir James Smith originally described it as a *Davallia*.[1] His description reads—

> 7. D. *pectinata,* fronde lanceolata pectinato-pinnatifida: laciniis obtusis undulatis multifloris; infimis auriculatis semipinnatisve.
>
> *Habitat* in India Orientali, *D. Hurloch* 1786. eandem forte in Otaheite legit Nelson. *H. Banks.*

There are two sheets representing this species in Smith's herbarium. The first, labelled *Davallia pectinata,* contains two collections labelled "1 Malacca. June 1796. Mr. Chrisr. Smith." and "2 Ind. Or.: Soc: Unit: Frat.: 1786," this second collection is evidently the type, and agrees exactly with Gaudichaud's plate of *Nephrodium Gaimardianum.* In Rees's Cyclopaedia XI, Smith calls it "A native of Malacca, the Nicobar Islands, and Otaheite." It seems probable therefore that Smith considered that the "Ind. Or." plant was from the Nicobar Islands. There is also what appears to be a duplicate in Herb. Mus. Brit., labelled "Nicobar Islands? Soc. Unit. Frat." Hurloch was an apothecary through whom plants collected by members of the society (Moravians) were received.[2]

There is also another sheet labelled "1 Otheite, D. Nelson, H. Banks, 1790." and "2 do. Menzies 1803" on which Smith has written "*D. pectinata* var." This agrees with the figure of *D. pectinata* in Hooker and Greville Icones Filicum 2, t. 139. from a specimen collected in Tahiti by Menzies, except that the fronds are less markedly deltoid. This species is now left without a

[1] Memoires de l'Academie Royale des Sciences de Turin 5 (1793) 415.
[2] Journn. Bot. (1902) 388.

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valid name, as *Humata pectinata* (Sm.) Desv. must replace *H. Gaimardiana* (Gaud.) J. Sm. I, therefore, propose a new name for it, but as Nelson's specimens are poor in both the herbaria of Smith and Banks I propose to regard Bank's own collection, to which Solander gave a manuscript name, as the type.

HUMATA BANKSII sp. nov.

Rhizoma repens, distante radicans, squamosa; squamis lanceolatis, membranaceis, atrofuscis, margine pallidiore integre; frondibus singuli dispositis, erectis, glabris, coriaceis, ambitu oblongo-lanceolatis vel ovato-deltoideis, profunde pinnatis; pinulis anguste oblongo-lanceolatis, fertilibus crenulatis, inferioribus margine inferiore pinnatifidis; costa distincta; venulae laterales plerumque furcatae; sori submarginales, numerosi, venulorum apicibus singuli dispositi; indusium subreniforme, membranaceum; sporangiis longe pedicellatis.

Tahiti: *Banks 1769* (in Herb. Mus. Brit.).

While searching in Smith's herbarium for the type of *D. pectinata* Sm. I came across the types of several other species which seem worthy of notes.

It seems worth while to give Smith's description of new species published in Rees's Cyclopaedia as they have been overlooked and some of the names are not in Christensen's Index Filicum. The pages are not numbered, and the dates are taken from Jackson.[3]

2. DAVALLIA PILOSIUSCULA Sm. in Rees Cyclopaedia 11 No. 10 (1808).

10. D. *pilosiuscula*. Frond thrice compound pointed. Leaflets ovate, blunt, decurrent, crenate, hairy. Dots scattered, globose. Cover crenate. Sm. MSS. Communicated by the late Mr. Christopher Smith from Honimoa and Amboyna. *Frond* large and spreading, rough in every part with short tawny hairs, thrice compounded in the alternate order; the principal divisions taper-pointed; the ultimate ones ovate, blunt, crenate. *Dots* sparingly scattered, at some distance from the edge of the leaves, small, yellowish, globose, each invested with a turgid, membranous, pale brown or yellowish, cup-shaped, crenate cover.

There are two sheets in Smith's herbarium labelled "Honimoa-July 1797. Mr. Chris.[r] Smith." and "Amboyna-1796. Mr. Chris.[r] Smith." They are clearly the same species, the only difference being that the Honimoa specimen has slightly larger leaflets and fewer fructifications. They represent a species of *Microlepia* which falls under *M. speluncae* (L.) in the broad sense of Baker, though that species has been subdivided by

[3] Journ. Bot. 34 (1896) 307–311.

Prantl (in Arb. K. Bot. Breslau I, pp. 25–38), I think the Smith's plant is probably conspecific with the type of *M. speluncae* from Ceylon in Hermann's herbarium.

3. **DAVALLIA SETOSA** Sm. in Rees Cycl. X, No. 18 (1808).

18. D. *setosa.* Frond thrice compound, all over hairy. Leaflets alternate, decurrent, oblong, sinuated. *Dots* solitary in each sinus bristly. Sm. MSS. Found by Mr. Menzies in the Sandwich islands. The *frond* is perhaps two or three feet high, triply winged in an alternate order; the *leaflets* especially are very regularly alternate, decurrent, oblong, bluntish, sinuated so as to be almost pinnatifid. The *stalks* and whole *frond* are clothed with fine, bristly, or shaggy, pellucid, jointed hairs. *Dots* solitary near each sinus of the leaflets, round, brown, the *covers* concealed or clothed with numerous hairs like those of the frond.

The specimen in Smith's herbarium is labelled "Sandwich Islands. Mr. Menzies, 1803" and is the species commonly known as *Microlepia hirta* (Klf.) Presl; as Smith's name antedates *Davallia hirta* Klf. the species must be known as *Microlepia setosa* (Sm.) comb. nov.

4. **DAVALLIA MICROCARPA** Sm. in Rees Cycl. X, No. 24 (1808).

24. D. *microcarpa.* Frond thrice compound, lanceolate. Leaflets alternate, wedge-shaped, in two or three somewhat elliptical segments, abrupt. Dots in pairs, or solitary, minute. Sent us by the late Mr. Christ. Smith from Amboyna. The whole *frond* is rather smaller than the last, and lanceolate, the *pinnae* about the middle part being the longest, these as well as the lower ones, are nearly opposite, but this may be a variable circumstance. The segments of the *leaflets* differ materially from the last in being somewhat elliptical, and rather contracted at the extremity, which strikes the eye at first sight. The *dots,* conforming to this contraction, are very small and short. We cannot refer this to any species described by Swartz or Cavanilles, though it is unquestionably allied to some of the following. [The next is *D. chinensis* Sm.]

The specimen in Smith's herbarium is *Odontosoria chinensis* (Linn.) J. Sm.

5. **DAREA PECTINATA** Sm. in Rees Cycl. XI, No. 6 (1808).

6. D. *pectinata.* Frond pinnate. Main-stalks winged upwards. Leaflets crowded, nearly opposite, pinnatifid; segments lanceolate, obtuse, the lowermost palmate. In this beautiful species we are obliged to Mr. Menzies, who found it in the Sandwich islands. It is of a richer green than the foregoing. [*D. furcata* = *Asplenium achilleifolium.*] *Frond* linear-lanceolate, a foot high, with a short stalk. *Leaflets* numerous, crowded, nearly if not quite opposite, scarcely above an inch long, linear-lanceolate, bluntish, cut into several lanceolate bluntish segments; all simple, except here and there one which is slightly cloven, and the first at the base of each leaflet at its upper edge, which is palmate. *Lines* rather longer, and much narrower, than in the last.

There is a specimen in Smith's herbarium labelled "Sandwich Islands. Menzies. 1803. Darea pectinata." It is a dareoid form of some species of *Asplenium*.

6. DAREA MICROPHYLLA Sm. in Rees Cycl. XI, No. 9 (1808).

9. D. *microphylla*. Frond doubly pinnate. Leaflets doubly pinnatifid; segments uniform, linear. Cover jagged. Brought by Mr. Menzies from the Sandwich islands. The *frond* is three feet or more in height, far more compound than in any other known species; insomuch that each consists, at a very moderate computation, of at least million of segments; and as ten capsules, if not more, may be reckoned to each segment, one with another, the quantity of seeds produced by each plant will be found so immense, that if they and their offspring were to increase for a few years at the same rate, the land of the whole globe would be covered with this fern, as, according to Linnaeus's computation, the offspring of one haddock would in twenty years fill up the whole ocean. The principal divisions of the *frond* very much resemble the leaves of *Achillea millefolium.* They are alternate, and alternately pinnate, each *pinna* being in like manner doubly and deeply pinnatifid, of a dark green; the alternate segments uniform, about a line in length, linear, or somewhat lanceolate, bluntish, often with a minute curved point. *Dots* dark brown, chiefly on the lowermost segments. *Covers* broadish, transparent, brown, jagged or crisped.

There is a specimen in Smith's herbarium labelled "Sandwich Islands. Mr. Menzies 1803. Darea microphylla."

This species falls under *Asplenium* (*Athyrium*) *aspidioides* Schlect. which Christensen calls *Athyrium scandicinum* (Willd.) Presl. The Hawaiian plant has since been separated as *Athyrium Poiretianum* (Gaud.) Presl and *A. Baldwinii* (Hillebr.). *Asplenium vexans* Heller seems to be the same species, which might be referred to *Asplenium* with equal reason. It may stand as *Athyrium microphyllum* (Sm.) comb. nov.

7. DAREA HETEROPHYLLA Sm. in Rees Cycl. XI, No. 12 (1809).

12. D. *heterophylla*. Frond deeply pinnate. Barren leaflets rhomboid, cut and serrated; fertile ones superior, deeply pinnatifid; their segments linear; sometimes forked. A native of New South Wales, near Port Jackson, from whence we received it through the hands of the late R. Molesworth esq. It is one of the finest and most remarkable of its genus. *Frond* about two or three feet high, of a palish, somewhat glaucous green, smooth, broad, doubly and alternately pinnate. The lower *leaflets* tilt towards the middle of the frond, are barren, about an inch long, of a broad lanceolate figure, inclining to rhomboid; dilated, lobed, and approaching to auricled, at their base; their margin jagged and serrated: all the upper leaflets of the same dimensions, but very deeply pinnatifid, their segment alternate, linear, acute, entire, some of the lower ones occasionally cloven or forked. The upper edge of each segment is almost entirely occupied by a long *line* of fructification, whose reflexed, smooth whitish *cover* is very conspicuous. *Capsules* very numerous, brown.

There is a specimen in Smith's herbarium labelled "New South Wales. R. Molesworth Esq:[r] = Darea (heterophylla)."

It is the species currently known as *Asplenium dimorphum* Kunze (1850), a native of Norfolk Island: fortunately there is already an *Asplenium heterophyllum* Presl. (1825).

8. HEMIONITIS STIPITATA Sm. in Rees Cycl. XVII, No. 8 (1811).

3. H. *stipitata.* Frond undivided, elliptical, ribless, the length of its stalk. Fructification in deep channels.—Sent from Amboyna by the late Mr. Christopher Smith.—*Frond* the length and breadth of the last, [*H. reticulata Forst.*] being about two inches wide and six long, but scarcely falcate; the base is broad, and not much decurrent, with a slight short rib, scarcely discernible, in that part only. The *stalk* is equal in length to the frond or leaf, linear, square, smooth, and naked. Lines of *fructification* disposed as in the last, but those towards the margin are rather more zigzag; all are deeply sunk into the leaf, causing the upper side to project remarkably, in a beautiful sort of net work.

Smith's specimen is *Antrophyum plantagineum* (Cav.) Kaulf.

9. HEMIONITIS TRILOBA Sm. in Rees Cycl. XVII, No. 9 (1811).

9. H. *triloba.*—Frond pinnate; leaflets three-lobed, sinuated, taper-pointed, downy, stalked; the lowermost terminate.—Communicated from the Brasils by the late Sir Geo. Leonard Staunton bart. in 1793. It is evidently akin to the last [*H. rufa* Sw.—*Gymnopteris rufa* (L). Bernh.] of which it might perhaps be deemed a variety, but the whole *frond* is shorter, though the leaflets are larger; they are also hairy and more finely downy, more waved and often sinuated, taper-pointed, three-lobed, sometimes very deeply, at their base; their partial stalks much longer, and the lowermost pair compound or ternate, at least occasionally so. The terminal leaflet is large, very deeply three-lobed. All are of a light green. Lines of *capsules* numerous, but much less crowded, and much more repeatedly forked. This is a most elegant fern, of which we can find no account. It can scarcely be *Asplenium tomentosum,* Lamarck. Dict. V. 2.308, found in Brazil By Commerson and Dombery, which Swartz quotes from the foregoing, and the description of which best agrees with that species.

There is a specimen in Smith's herbarium labelled "Brasil Sr. G. Staunton Bart. 1793–Hemionitis triloba." It is *Gymnopteris tomentosa* (Lamk.) Und. as illustrated in Fl. Bras. t. 36 f. 3–4.

10. HEMIONITIS POLYPODIOIDES Sm. in Rees Cycl. XVII, No. 11 (1811).

11. H. *polypodioides.*—Frond pinnate, distinct; leaflets sessile, oblong, pointed, pinnatifid; their lobes obtuse, entire.—Gathered in Hispaniola by the celebrated M. Thiery de Menonvilles. We find nothing like it in Plumier. The *frond* is about the size of *Aspidium Oreopteris,* and the innumerable, short decussating lines of capsules give it the aspect of a true Polypodium. The leaflets are less deeply pinnatifid than in *A. Oreopteris,* but otherwise not very unlike that fern. They are smooth, though their stalk and ribs are finely silky.

There is a specimen in Smith's herbarium labelled "*Hemionitis*—St. Domingue thierry.—polypodioides. Th. No. 95." It is a species of *Diplazium* which I am unable to identify with certainty. The specific name *polypodioides* is preoccupied in *Diplazium.*

11. ISOETES UNILOCULARIS Roxb. ex. Sm. in Rees Cycl. XIX, No. 3 (1811).

Smith makes three species of *Isoetes,* including the following new one but omitting *I. coromandelina* Linn. f.

The description reads—

3. *I. unilocularis.* Indian Quillwort.—Roxb. MSS.—Fronds somewhat triangular, erect. Capsules elliptical, if one cell. Sent from the coast of Coromandel by Dr. Roxburgh. Koenig sent what appears certainly to be the same, in a younger state, to Linnaeus by the name of *I. indica,* as found in ponds on a sandy soil, in December. In these latter specimens the *root* of each is a globose tuber. *Fronds* about six, erect, straight, slender, obscurely triangular with a broad membranous base. *Fructification* too young to be discernible. Dr. Roxburgh's specimen consists of separate *fronds,* larger than the former, as being more advanced, but otherwise exactly similar, the base of each winged with a broad membrane, and lodging on elliptical, slightly compressed, membranous, brownish *capsule,* from above half an inch to near an inch long, one of cells, whose inside is lined with innumerable compressed membranous stalks, each bearing a beautiful white *seed,* convex and granulated below, triangular and smooth above. A spongy body, above the capsule, but, in our specimens, disjointed from it, is lodged in the substance of the leaf, and the same is indicated by the figure of the first species in Engl. Bot. in both male and female flowers, as well as by Linnaeus in his *Iter Scanicum.* Having never had an opportunity of tracing the progress of the fructification, we are not certain whether this to be the part called sometimes calyx, sometimes receptacle, but if so the capsule is reversed.

The specimen appears to be a large form of *I. coromandelina* Linn f.

12. LINDSAEA GRANDIFOLIA Sm. in Rees Cycl. XXI, No. 12 (1812).

5. L. *grandifolia.* Frond pinnate; leaflets opposite, elliptic-lanceolate, pointed. Fructification half way between the rib and the margin.—Gathered in Malacca.—We know this merely from a pencil sketch taken by the younger Linnaeus, marked with the native country of the plant, and a note saying it "probably constitutes a new genus, of which Aublets tab. 365 and 366 and an *Adiantum* of Smeathman's, are other species." This was perhaps written at Sir Jos. Banks's; but if so we cannot account for Mr. Dryander's having omitted this species, which appears to be one of the most remarkable of the whole number. The *frond* consists of two pair of opposite slightly stalked, leaflets, three or four inches long, with a terminal one still longer. A line of fructification lies midway between the rib and the margin, on each side of the former, but none of the lines extend either to the base or the summit, by near an inch.

The drawing is still in Smith's herbarium. It is undoubtedly *Taenitis blechnoides* (Willd.) Sw.

13. **WOODWARDIA FIMBRIATA** Sm. in Rees Cycl. XXXVIII, No. 6 (1818).

6. W. *fimbriata.* Fringed Woodwardia.—Frond pinnate; leaflets sessile, deeply pinnatifid, with spreading, rather acute, lobes, fringed with sharp teeth.—Gathered by Mr. Menzies, on the West coast of North America. This is larger in every part than *W. virginica,* and distinguished from that species by its more acute segments, whose margin is very conspicuously and copiously fringed with prickly teeth, directed towards the point. *Groups* of capsules large and turgid, ranged, a little obliquely, along the ribs of the segments, from three to five pair on each segment, none at the mid-rib of the leaflet itself. *Involucrum* strongly and permanently vaulted. The bottom lobe of each *leaflet* at the lower side, is shortened, dilated, and half heart-shaped as is more rarely the case in *W. virginica.* Several of the upper *leaflets* are decurrent and confluent; the top ones undivided and barren.

There is a specimen in Smith's herbarium labelled "Western North America, Menzies 1803;" and at the British Museum, a duplicate labelled "Northwest coast of America: New Georgia. Mr. Menzies," is a form of the plant commonly called *W. Chamissoi* Brack., the W. American representative of *W. radicans.*

This number of the Encyclopaedia is dated 1819, but Jackson [4] gives the date as 31 July 1818.

14. **ASPIDIUM BLECHNOIDES** Sm. in Rees Cycl. XXXIX [No. 11] (1818).

[No. 11.] A. *blechnoides.* Long-leaved shield-fern. (Polypodium exaltatum; Linn. Syst. Nat. ed. 10. V. 2. 1326. Sp. Pl. ed. 2. 1549; excluding the synonyms, and substituting the following. Filix minor, in pinnas tantum divisa, recbras non crenatas, inferiore latere auriculatas, et rotundis pulverulentis, areolas, aversa parte notatas; Sloane Jam. V. I. 86. t. 44. f. 1.)—Frond pinnate; leaflets linear-lanceolate, elongated, entire, with a rounded incurved auricle at the base on the lower side, and a slight dilatation on the upper. Masses of capsules in a double row. Native of Jamaica, on the sides of hills. Linnaeus received his specimen in Brown's herbarium, with an erroneous reference to Sloane's t. 31, which belongs to our last described [*A. exaltatum* Sw.]. Hence there has always been a confusion respecting these two ferns, which even Dr. Swartz could not reconcile; see his Syn. Filicum, 65, where he cites Sloane's t. 44, but ought to have added *fig.* I; as Fig. 2. is *Blechnum occidentale.* The specific name of *Polypodium exaltatum,* being taken from Plumier's & Sloane's accounts of the foregoing, and that being universally received as *Aspidium exaltatum,* we have not changed its denomination. That name is not at all applicable to the species before us, which is more expressively called *blechnoides.* Its height is only eighteen or twenty inches. *Leaflets* from four to six inches long, taper-pointed; the lower auricle of each overlap-

[4] Journ. Bot. 34 (1896) 311.

ping the main stalk, and hooked or curved in a curious manner, not well expressed in Sloane's plate. *Sori* in double rows close to the mid-rib at each side. *Involucrum* perfectly peltate, orbicular, and entire.

The plant figured by Sloane Jam. I. t. 44. f. 1, is in Herb. Sloane 1. p. 94 and is the species now called *Cyclopeltis semicordata* (Sw.) J. Sm.

Linnæus, in his description of *Polypodium exaltatum* quoted Sloane t. 31, which may be taken as the type. The specimen is in Herb. Sloane, 1, p. 52 and is the species currently known as *Nephrolepis exaltata* (Linn.) Schott.

The following new names were also published in Rees's Cyclopaedia:—

ACROSTICHUM DISTANS (R. Br.) Sm. in Rees Cycl. XXXIX [No. 25].

Based on *Northolaena distans* R. Br. which is the name still in use.

ACROSTICHUM LIMBELLATUM Sm. in Rees Cycl. XXXIX [No. 3].

Based on Plumier Fil. p. 113. t. 129., from Le Morne Rouge, Martinique.

There is no specimen in Smith's Herbarium and his description is presumably adapted from Plumier.

BOTRYCHIUM FUMARIANUM Sm. in Rees Cycl. XXXIV, No. 4 (September, 1819).

Based on *B. fumarioides* Willd.

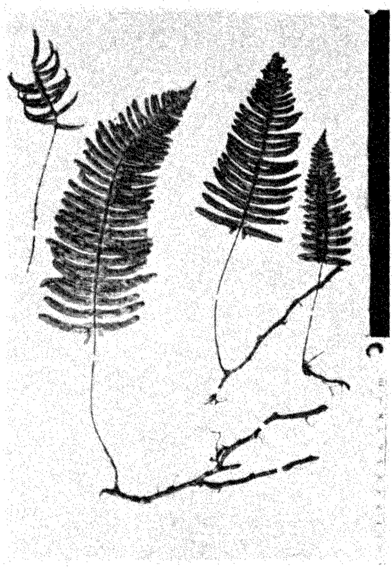
ONOCLEA PENSYLVANICA Sm. Op. Cit. XXV, No. 3 (1813).

Based on *Struthiopteris pensylvanica* Willd.

ILLUSTRATION

PLATE 1

FIG. 1. *Davallia pectinata* Smith, type.
2. *Davallia pilosiuscula* Smith, type.
3. *Davallia setosa* Smith, type.
4. *Woodwardia fimbriata* Smith, type.



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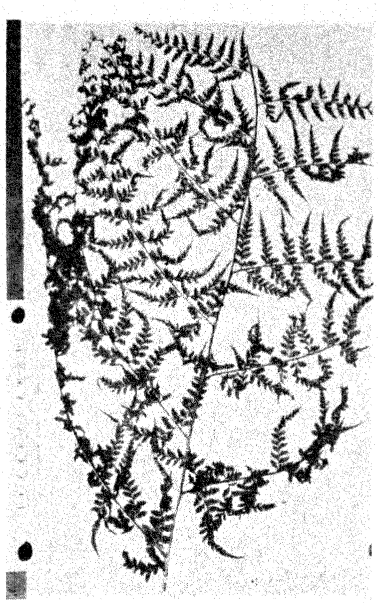

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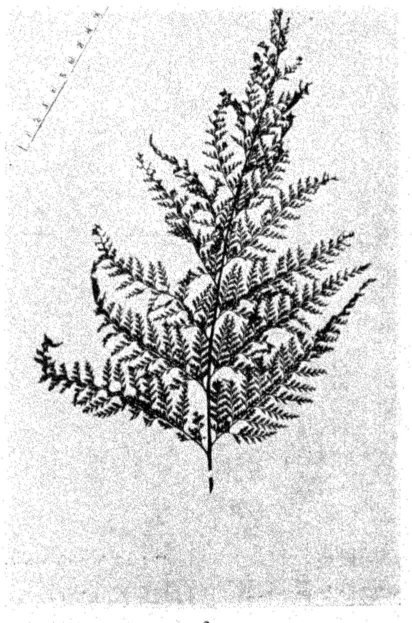

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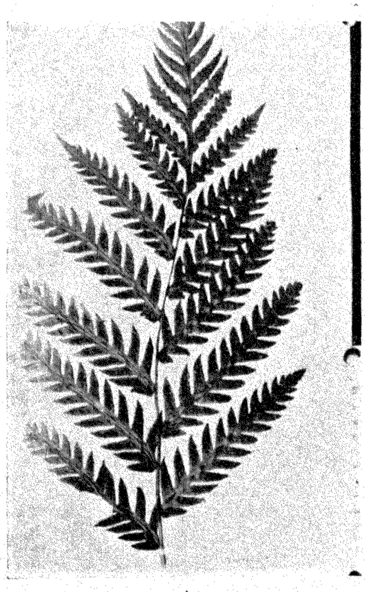

4

PLATE 1.

SOLAR ULTRAVIOLET RADIOMETRY

I, THE ULTRAVIOLET LIMIT OF SUNLIGHT

By WM. D. FLEMING

Major, Medical Corps, United States Army; Member, United States Army Medical Department Research Board, Bureau of Science, Manila

The short-wave-length limit of sunlight as it reaches the earth is generally taken as about 290 millimicrons.(1, 2, 3, 4, 5) This limit has been found both at sea level and at heights as great as 9,000 meters.(3)

The question as to whether this limit might not be extended in the Tropics has often been raised. Freer and Gibbs(6) made solar spectrographs in Manila in 1910 and concluded that the limit was 291 millimicrons in that place, in close agreement with workers elsewhere.

Since the time that Freer's work was done, a refinement of technic was developed and aëroplanes became available for quickly attaining altitudes above the dust and moisture of sea level. In connection with other work now being done on solar ultraviolet radiometry, it seemed advisable to examine this question again.

The new technic mentioned consists simply in coating the photographic emulsion with a thin layer of mineral oil before exposure. After exposure this oil is washed off with carbon tetrachloride and alcohol; the plate is rinsed in water and then developed as usual. When ultraviolet light strikes the coating of oil it causes this oil to fluoresce. The image is impressed on the emulsion by this fluorescence. This method was developed chiefly for photography of the far ultraviolet, where the gelatine of the plate absorbs the light very strongly. However, its use in the ultraviolet region of 290 millimicrons was thought advisable since it might serve to intensify weak light present in this region.[1]

[1] This technic is now so well known it is impossible to trace its origin.

EXPERIMENTAL

All exposures were made with a small quartz spectrograph made by Hilger. The dispersion was such that the spectrum from 190 to 800 millimicrons occupied 9.5 centimeters of which 0.5 centimeter was occupied by the region 280 to 300 millimicrons. Length of spectrum was necessarily sacrificed to attain the portability required for handling the instrument, especially in an aëroplane.

Wave lengths were located roughly by the wave-length scale of the instrument, photographed on the plate, and were checked in each instance by a line spectrum of mercury photographed on the plate in close proximity to the solar spectrum, using a mercury arc in quartz as a light source. Eastman 36 plates were used. Development was by Eastman formula D61a. For oiling the plates, liquid petrolatum, heavy, U. S. P. was used.

There was considerable diffuse blackening of the plates due to diffuse light reflected from the prism face. From plate 18 on, this diffused light was cut considerably by a diaphragm of black paper placed in front of the prism, but there was still enough diffuse darkening of the plate extending down into the extreme ultraviolet to render the exact end of the solar spectrum somewhat doubtful. In all cases the termination of the solar spectrum was read as the last Fraunhoffer line visible.

Two exposures were made from an aëroplane at an altitude of 10,000 feet as read on the standard Army Air Corps altimeter. The planes used were Army Air Corps double-engine bombers. The spectograph was placed in the nose cockpit; this was done to avoid exposing through any motor exhaust gasses.

RESULTS

The data on the plates exposed are given in Table 1.

Two of the long exposures gave reversed images of the spectrum similar to a positive print rather than the usual negative.

The shortest wave length that could be seen with certainty was 293 millimicrons. This appeared on both aëroplane exposures made at 10,000 feet elevation and on one of the Baguio plates at 4,800 feet elevation.

CONCLUSION

No evidence was found that the solar spectrum in Manila and Baguio extends any farther into the ultraviolet than the limit previously found by Freer and Gibbs; that is, 291 millimicrons.

TABLE 1.—*Data on plates exposed from aëroplanes.*

No.	Date.	Time.	Place.	Type.	Exposure.	Spectral limit.	Remarks.
	1931					$m\mu$	
13	Mar. 9	10.40	Manila	Oiled	Sky; 10 seconds to 10 minutes	295	
14	Mar. 10	11.00	do	Plain	Sun; 10 seconds to 30 minutes	300	Plate fogged in development. Image of long exposures reversed.
15	Mar. 26	11.15	do	Oiled	Sun; 5 seconds	297	
16	Mar. 29	11.00	do	Plain	North sky; 1 hour	296	
17	Mar. 31	11.45	Laguna de Bay	Oiled	Sun; 5 seconds	293	Exposed from aëroplane; 10,000 feet altitude.
18	Apr. 1	10.30	Manila	do	Sun; 60 seconds	294	
19	Apr. 6	10.30	do	do	Sun; 5 minutes	295	
20	Apr. 7	11.00	do	do	Sun; 60 minutes	305	Image reversed.
21	Apr. 21	11.30	Corregidor, Manila Bay	do	Sun; 5 minutes	293	Exposed from aëroplane; 10,000 feet altitude.
	1932						
54	Jan. 7	3.30	Baguio	do	Sun through thin cloud; 60 seconds	300	4,800 feet altitude.
55	Jan. 9	10.55	do	do	*a.* Sun; 75 seconds	293	Do.
					b. Sun; 120 seconds	293	Do.

ACKNOWLEDGMENT

The writer desires to express his appreciation of the cordial coöperation of the personnel of the Air Corps of the Philippine Department in the aëroplane flights performed for this work. In particular, he is grateful to 2d Lt. A. J. Kerwin Malone, Air Corps, United States Army, and to 2d Lt. Wentworth Goss, Air Corps, United States Army, for their piloting of the aëroplanes for the flights made.

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CHEMICAL AND BIOLOGICAL ANALYSES OF TIKITIKI EXTRACTS

By A. J. HERMANO and FÉ ANIDO
Of the Bureau of Science, Manila

SEVEN TEXT FIGURES

The purpose of this paper is to ascertain the comparative biological value and chemical analyses of rice-bran (tikitiki) extract prepared by various manufacturers in the Philippine

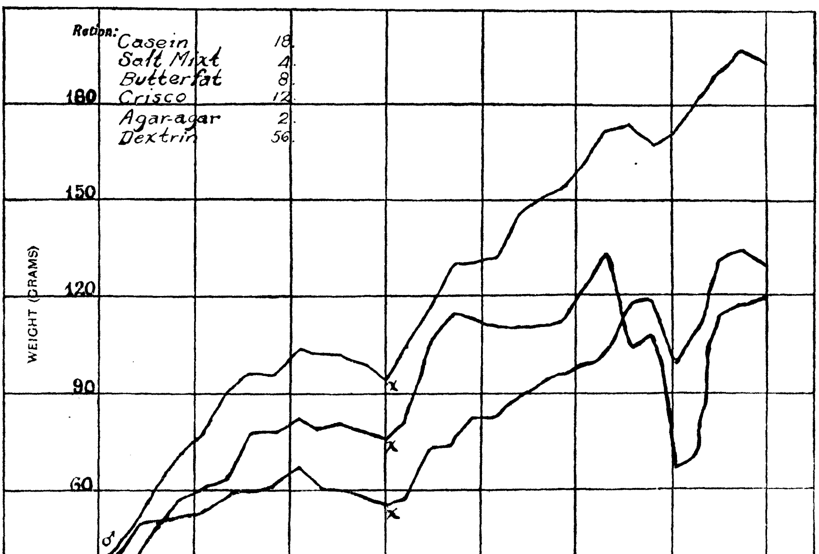

FIG. 1. Weights of white rats. The rats were fed a vitamin-B-free basal diet. At the point x each rat was given daily 0.2 cubic centimeter of brand 1 tikitiki extract. Cage 42.

Islands. Rice polishings (darak), used for making the extract, is a by-product in the milling and polishing of rice. It is composed mostly of the brown coating (pericarp), the germ, tiny particles of broken kernels, and a small quantity of husks. The crude tikitiki is a good feed for hogs, horses, chickens, pigeons,

etc., and the very fine and nonrancid kind, mixed with wheat flour makes tasty and nourishing bread, hot-cakes, cookies, muffins, and biscuits.

Tikitiki extract is used extensively in the prevention and cure of infantile beriberi and, to some extent, of malnutrition of adults. It has been found to be effective in the prevention and cure of polyneuritis in pigeons, chickens, rats, etc.

Wells,[1] working in the Philippine Bureau of Science, published the bureau's method and procedure for manufacturing extract of rice polishings (concentration 1 cubic centimeter = 20 grams crude tikitiki), and according to Santos and Collado,[2] 0.5 cubic centimeter of this extract is sufficient for a daily supplement of the deficient ration of albino rats. Jansen and Donath [3] reported the isolation of a crystalline antineuritic vitamin, from rice polishings to which they ascribed the formula $C_6H_{10}ON_2$, and they stated that 0.5 milligram of their pure antineuritic vitamin corresponds to the potency contained in about 30 grams of rice bran.

MATERIALS

For this investigation crude rice polishings and seven brands of tikitiki extract were used. The crude bran (darak) was the usual quality purchased by the Bureau of Science for the manufacture of the extract. Six rice-polishing extracts were submitted by the Board of Pharmaceutical Examiners and Inspectors, and one extract was the product made by the Bureau of Science.

EXPERIMENTAL PROCEDURE

The chemical analyses of the crude rice polishings and the tikitiki extracts were made according to the methods of the Association of Official Agricultural Chemists.[4] The generally accepted biologic test for antineuritic vitamin was adopted. The basal ration, test for vitamin B, was prepared and fed to twenty-two albino rats, which were allowed to decline in weight. The animals were given plenty of artesian-well water. After the animals declined in weight each rat was given daily 0.2 cubic centimeter of tikitiki extract as supplement to the antineuritic deficiency in the basal ration.

[1] Philip. Journ. Sci. 19 (1921) 67–73.

[2] Philip. Agriculturist 14 (1925) 243–245.

[3] Mededeelingen Dienst Volksgezondheid Nederlandsch-Indie 16 (1927) 186–189.

[4] Official and Tentative Methods of Analysis. Association of Agricultural Chemists (1925).

Tables 1 and 2 represent the chemical analyses of the crude rice bran (polishings) and the tikitiki extracts, and text figs. 1 to 7 demonstrate the biological tests on albino rats.

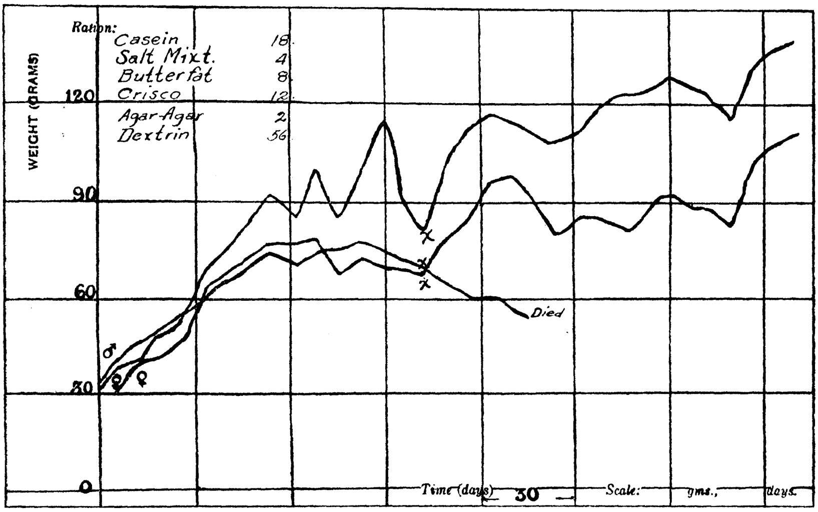

FIG. 2. Weights of white rats. The rats were fed a vitamin-B-free basal diet. At the point x each rat was given daily 0.2 cubic centimeter of brand 2 tikitiki extract. Cage 50.

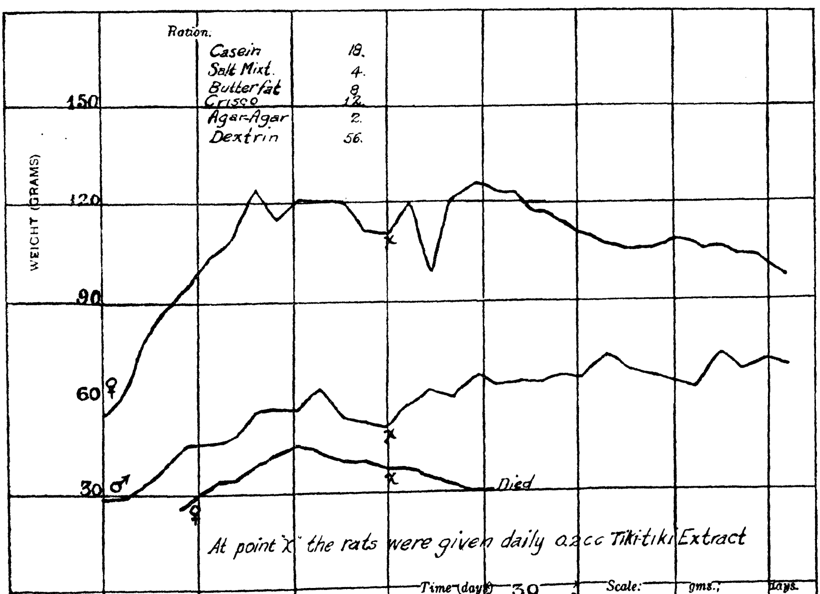

FIG. 3. Weights of white rats. The rats were fed a vitamin-B-free basal diet. At the point x each rat was given daily 0.2 cubic centimeter of brand 3 tikitiki extract. Cage 45.

TABLE 1.—*Analysis of rice bran.*

	Per cent.
Moisture	9.02
Fat (ether extract)	16.96
Protein (N × 6.25)	13.81
Ash	11.94
Crude fiber	9.91
Carbohydrates (by difference)	38.36
Total	100.00

TABLE 2.—*Chemical analyses of seven brands of tikitiki extract.*

Tikitiki extract; prepared by different manufacturers.	Specific gravity at 27.5° C.	Total solids.	Ash.	Alkalinity of ash in 100 g. sample.	Basic and acid radicals in the ash.
		Per cent.	*Per cent.*	*g. KOH*	
Brand 1	1.5592	70.68	6.70	2.15	Ca, Mg, K, Na, Cl, and S.
Brand 2	1.3115	71.03	5.83	2.37	Do.
Brand 3	1.5894	65.52	8.99	0.586	Do.
Brand 4	1.3723	61.66	4.99	0.45	Do.
Brand 5	1.3263	45.92	4.72	1.85	Do.
Brand 6	1.3526	65.12	4.93	2.01	Do.
Brand 7	1.3189	70.37	3.54	0.34	Do.

Tikitiki extract; prepared by different manufacturers.	Nitrogen.	Phosphorus pentoxide.	Sucrose.	Reducing sugars.		Boric acid, borate, and salicylic acid.	Alcohol.
				Before inversion.	After inversion.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
Brand 1	1.17	2.07	9.31	20.16	21.33	None	None.
Brand 2	1.77	1.52	1.57	21.64	23.39	do	Do.
Brand 3	1.30	2.70	4.09	20.21	21.22	do	Do.
Brand 4	1.09	1.84	18.13	20.34	30.92	do	Do.
Brand 5	0.66	1.49	1.77	24.62	26.84	do	Do.
Brand 6	0.58	1.58	14.21	19.16	32.41	do	Do.
Brand 7	1.21	1.68	1.27	28.35	29.99	do	Do.

DISCUSSION

Administrative Decision No. 170–A, adopted by the Board of Food and Drugs Inspection August 24, 1917, defines tikitiki extract as follows:

Tikitiki Extract is the extract prepared according to the Bureau of Science method from fresh clean rice bran (tikitiki) showing no mold or other signs of deterioration. The extract should contain no substances foreign to the bran.

On analysis the finished extract should show the addition of no substances which lower the strength or therapeutic value of the product; it

should show not more than slight traces of alcohol and should contain no preservatives; it should contain neither less than three (3) per cent nor more than six (6) per cent of total ash; the alkalinity of the total ash from five (5) grams of finished extract should be neither less than four (4) cubic centimeters nor more than six and five-tenths (6.5) cubic centimeters of tenth normal acid using phenolphthalein as an indicator.

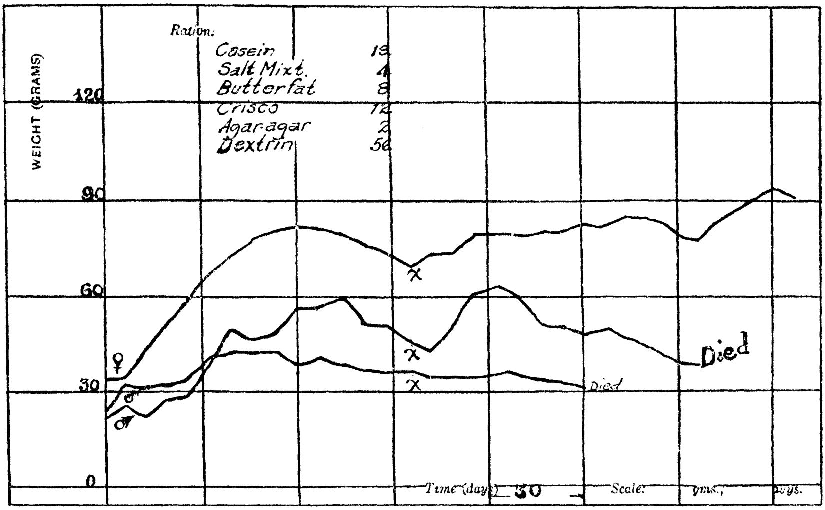

FIG. 4. Weights of white rats. The rats were fed a vitamin-B-free basal diet. At the point x each rat was given daily 0.2 cubic centimeter of brand 4 tikitiki extract. Cage 49.

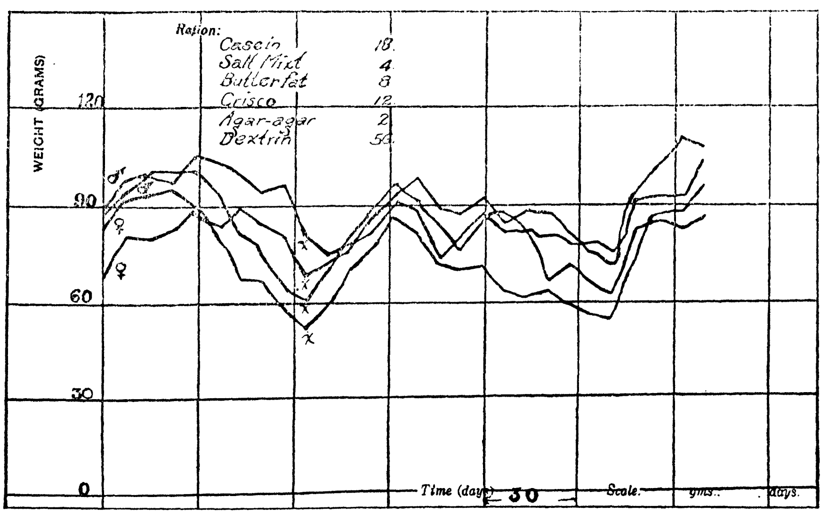

FIG. 5. Weights of white rats. The rats were fed a vitamin-B-free basal diet. At the point x each rat was given daily 0.2 cubic centimeter of brand 5 tikitiki extract. Cage 40.

RESULTS

Results of the chemical analyses recorded in Table 1 show that rice bran has a fairly high fat content, and the protein is also higher than that of polished rice kernels.

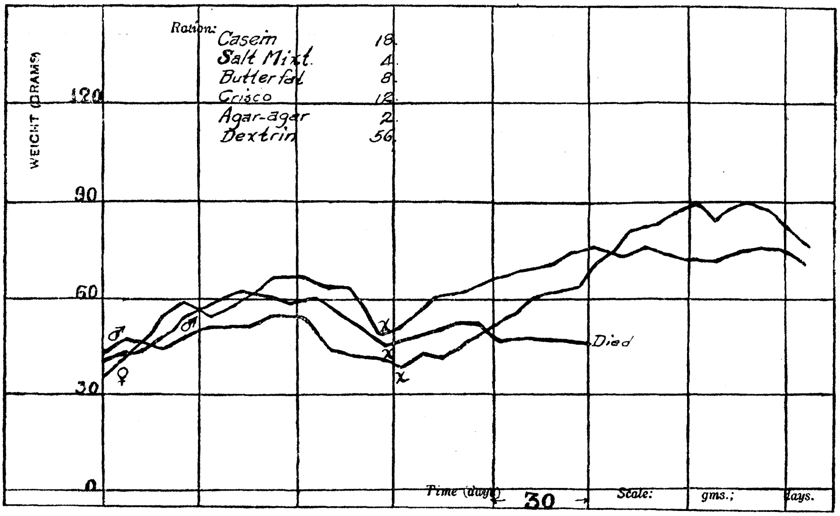

FIG. 6. Weights of white rats. The rats were fed a vitamin-B-free basal diet. At the point x each rat was given daily 0.2 cubic centimeter of brand 6 tikitiki extract. Cage 52.

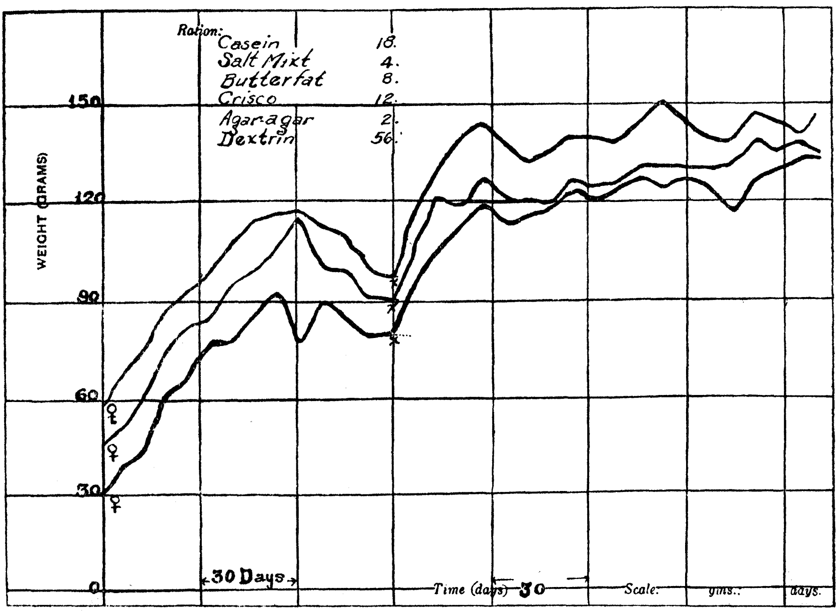

FIG. 7. Weights of white rats. The rats were fed a vitamin-B-free basal diet. At the point x each rat was given daily 0.2 cubic centimeter of brand 7 tikitiki extract. Cage 59.

From the resulting data (Table 2) it is evident that sugar has been added in the preparation of brands 1, 3, 4, and 6.

In carrying out our biological tests four rats out of twenty-two died; and eighteen, which declined in weight due to lack of antineuritic vitamin in the basal ration, were cured and maintained their growth on a daily supplement of 0.2 cubic centimeter tikitiki extract added to the deficient ration.

Brands 1, 5, and 7 were found to be excellent sources of antineuritic vitamin. The charts for brands 2, 3, and 6 demonstrate that the extracts are only a fairly good source of antineuritic vitamin as but two rats out of three were cured.

Brand 4 was not a good source of antineuritic vitamin, as only one rat out of three was cured.

SUMMARY

Chemical and biological analyses were made of rice bran and also of seven samples of tikitiki extract prepared by different manufacturers.

Three samples were found to be excellent sources of antineuritic vitamin. Three samples were only fairly good sources, and one sample was found to contain very little antineuritic vitamin.

ILLUSTRATIONS

TEXT FIGURES

Weight Charts of White Rats Used in Testing Various Brands of Tikitiki Extract

SEROLOGIC STUDY OF CEREBROSPINAL FLUIDS IN PHILIPPINE MONKEYS INOCULATED WITH YAWS, SYPHILIS, OR BOTH

By Onofre Garcia

Of the Division of Biology and Serum Laboratory
Bureau of Science, Manila

That the serologic blood of infected experimental animals is quite similar to that encountered in syphilis and yaws of man has been demonstrated in a long series of serologic examinations.[1]

The present report concerns a considerable number of examinations performed on spinal fluids of monkeys that have been inoculated some time previous with yaws, syphilis, or both.[2] At the time the spinal fluid was examined the animals showed no clinical sign of disease. At the same time that the spinal fluid was withdrawn a sample of blood was secured from each animal. The blood serum and the spinal liquid were simultaneously subjected to the same serologic tests.

TECHNIC OF WITHDRAWING THE CEREBROSPINAL FLUID

The monkey was tied to an animal board, the ventral side down. The occipital region was shaved and cleansed with 95 per cent alcohol. The place where puncture was to be made was disinfected with tincture of iodine, which was later removed with alcohol. The posterior portion of the neck was extended, the helper holding the head down. This position was maintained by placing a small box under the animal's breast.

Taking as a guide the external protuberance of the occipital bone, a hypodermic needle about 3 centimeters long was slowly pushed down into the subdural space in the middle occipital line. If the needle is properly inserted and reaches the cerebral-medullary cistern the fluid comes out freely. As much as 5 cubic centimeters may be obtained in such a way without the slightest injury to the monkey. The animal may occasionally show symptoms of shock, but soon recovers from it.

[1] Philip. Journ. Sci. 35 (1928) 261–272; 40 (1929) 55, 71, 75, 79, 80; 42 (1930) 203–211.

[2] These animals, inoculated originally in various experiments by Dr. Otto Schöbl and his coworkers, were placed at our disposal by Doctor Schöbl.

TABLE 1.—*Showing the results of Wassermann and Kahn tests with the blood serum and cerebrospinal fluid of monkeys. The duration of infection is also given.*

Designation of monkey.	Period between first inoculation and last Wassermann test.		Last test of the blood serum.		Cerebrospinal fluid.				
					Quality of fluid.	Wassermann.			Kahn.
	Yrs.	mos.	Wassermann.	Kahn.		Alcohol.	Control.	Cholesterinized.	Antigen 0.01.
Sy-3	2	0	++	+	Faintly bloody	—	—	±	+
U-1[a]	3	0	+++	++++	First bloody	—	—	—	+
					Second clear	—	—	—	—
W-25	2	5	++++	++++	Faintly bloody	—	—	—	—
W-23	2	5	++	+++	Clear	—	—	—	—
W-27	2	5	++	++++	Faintly bloody	—	—	—	—
Sy-G-20	1	5	+++	++++	do	—	—	—	—
Sy-I-11	1	4	++	++	do	—	—	—	—
Sy-P-23	0	9	++++	—	do	—	—	—	—
Sy-J-20	1	5	++	±	do	—	—	—	—
J-11	4	5	++++	++	Clear	—	—	—	—
T-4	4	2	++++	++	do	—	—	—	—
j-1	1	9	++++	++	Faintly bloody	—	—	—	—
E-41	2	5	++++	++++	Clear	—	—	—	—
Yac-10	0	9	++	++	do	—	—	±	—
L-13	1	4	++	—	do	—	—	—	—
O-c-1	1	4	++	—	do	—	—	—	—
O-c-2	1	4	++++	—	Faintly bloody	—	—	—	—
Sy-G-22	1	6	±	—	do	—	—	—	—
K-25	0	7	±	—	Clear	—	—	—	—
K-26	0	7	±	—	do	—	—	—	—
Y-G-25	1	3	++++	++++	Faintly bloody	—	—	—	—

YB-9	0	10	++++	++++	Clear	—	—	+	—
YM-20	0	8	++	+	do	—	—	—	—
f-2	2	1	++++	++++	Faintly bloody	—	—	—	—
F-38	1	0	++	±	Clear	—	—	—	—
K-13	1	2	++++	+	Faintly bloody	—	—	—	—
J-18	2	4	++++	++	Clear	—	—	—	—
Z-1	1	7	++++	++	Faintly bloody	—	—	—	—
Monkey 1	2	0	—	—	do	—	—	—	—
L-15	1	3	+++	+++	do	—	—	—	—
K-12	1	2	++	++	Clear	—	—	—	—
K-27	0	7	±	—	Faintly bloody	—	—	—	—
K-28	0	7	++	+	Clear	—	—	—	—
Sy-D-20	1	1	++	+	do	—	—	—	—
Sy-P-25	0	9	—	—	do	—	—	—	—

a Tested twice.

TECHNIC OF SEROLOGIC TESTS EMPLOYED

The cerebrospinal fluid, whether of bloody appearance or not, was centrifuged before it was subjected to Wassermann and Kahn tests. In the Wassermann test as herein employed alcoholic and cholesterinized antigens, as well as serum controls, were used.[3] The amount of fluid used for this test varied from 0.3 to 0.5 cubic centimeter.

The Kahn test was performed according to the qualitative procedure with spinal fluid described by Kahn.[4]

DISCUSSION

The duration of infection in the monkeys employed in this investigation varies from seven months to four years.[5] (See Table 1.) The number and the kind of inoculation received by each monkey are indicated in Table 2. The animals herein employed were inoculated either with yaws or syphilis or both at different periods of time in the form of infection or vaccine treatment, superinfection, or test for immunity to syphilis or yaws. Positive late serologic response was found in the blood serum of most of the animals herein studied. They showed, however, no clinical manifestations of yaws or syphilis at the time the spinal fluid was tested.

Of the thirty-five monkeys whose spinal liquid was examined all but four gave frankly negative results by Wassermann as well as by Kahn tests. The four exceptions showed doubtful or weak positive results. Two samples of the four spinal liquids had admixture of blood which was macroscopically detectible. One of these animals was examined the second time, on which occasion a clear liquid was obtained, and the result of the second examination of the same animal was negative. It is regretted that death of the other three animals that gave doubtful serologic tests in the spinal fluid prevented us from confirming or correcting these findings. In view of the one instance where the result was corrected by repeated examination and on account of the strongly positive results obtained with the blood serum of the animals concerned, the doubtful and weakly positive serologic findings in the spinal fluid of the three remaining animals lack significance.

[3] Schöbl, O., and C. Monserrat, Philip. Journ. Sci. § B 12 (1917).

[4] The Kahn Test (a practical guide). The Williams and Wilkins Co. Baltimore (1928) Chap. 8.

[5] Philip. Journ. Sci. 35–43 (1928–30).

RESUME

The cerebrospinal fluids of thirty-five monkeys that were successfully inoculated with either yaws or syphilis or both gave uniformly negative results when tested by Wassermann and Kahn tests. The duration of infection in these animals varies between seven months and four years five months.

Thanks are due to Dr. Otto Schöbl for furnishing me with the material for this study.

The serologic tests of the blood and spinal fluid were performed simultaneously.

TABLE 2.—*Showing the number and kind of inoculations received by each monkey at different times.*

Designation of monkey.	Number and kind of inoculations.			
	Syphilis infection.	Yaws infection.	Syphilis vaccine.	Yaws vaccine.
Sy-3	2	1	0	0
U-1	1	4	0	3
W-25	1	7	0	2
W-23	1	7	0	3
W-27	1	7	0	2
Sy-G-20	3	2	0	0
Sy-I-11	2	4	0	0
Sy-P-23	2	4	0	0
Sy-J-20	2	2	0	0
J-11	2	6	0	0
T-4	2	5	0	0
j-1	1	2	0	0
E-41	1	2	0	1
Yac-10	1	2	0	0
L-13	1	3	0	0
O-c-1	1	3	0	0
O-c-2	1	3	0	0
Sy-G-22	2	5	0	0
K-25	0	3	3	0
K-26	0	3	3	0
Y-G-25	0	1	0	0
YB-9	0	2	0	0
YM-20	0	2	0	0
f-2	0	2	0	0
F-38	0	1	0	0
K-13	0	1	0	0
J-18	0	2	0	1
Z-1	0	1	0	(a)
Monkey 1	0	2	0	0
L-15	0	3	0	0
K-12	0	2	0	0
K-27	0	2	0	0
Sy-D-20	1	0	0	0
Sy-P-25	1	0	0	0

a Tissue from yaws.

AN ARTHROPOD ASSOCIATED WITH A CHRONIC DERMATITIS INVOLVING THE FACE

By Candido M. Africa

Of the School of Hygiene and Public Health
University of the Philippines, Manila

TWO PLATES

While the dog follicle mite, *Demodex canis* Leydig, causes a severe acariasis in the dog known as red mange, the follicle mite of man, *Demodex folliculorum* Simon, said to occur in 50 per cent of the population in all parts of the world, is generally considered as a harmless parasite. Braun (1) believes that it causes "inflammation of the sebaceous glands (comedones)" and that their "agglomeration in the meibomian glands (in man) sets up inflammation of the margins of the eyelids." Borrel, quoted by Castellani and Chalmers, (2) went a step further by believing, though on somewhat slender evidence, that this vermiform acarian is associated with the spread of cancer and leprosy. Herms (3) believes that the follicle mite may, under certain conditions, produce acnelike eruption, though it is hardly probable that many, if any, cases of "black-head" may be traceable to this mite. Recently, the writer came across a rather severe case of chronic dermatitis involving the face of an American long residing in the Philippines in which an arthropod answering the description of *Demodex folliculorum* Simon appears to be responsible (Plate 1). Desiring to contribute to the meager literature on the subject, the writer thought it worth while to publish the following case report together with the result of the treatment instituted therein.

CASE REPORT

The subject, J. P., is a male white American, 57 years old, married, native of Pennsylvania, residing in this country since 1899, except for an absence of two years (1917–1919), during which time he served in the American Expeditionary Force in France, where he received mustard-gas wounds which involved

almost the whole left side of the face, the upper lip, and a portion of the right temporal region including parts of the right ear. The lesions healed promptly, but the skin of the parts involved was completely destroyed, thus leaving smooth, unpigmented albinolike areas of granulation tissue which merged very gradually with the surrounding skin. For three years the patient had nothing to complain of except, perhaps, the unsightly look of the scars, which he knew was beyond remedy; but in 1922 he noticed pinhead vesicular eruptions along the borders of the scars which on being pressed yielded a whitish matter of pasty consistency. These eruptions would stay for months in spite of treatment and then would collapse and disappear, only to crop up anew in other parts. The borders of the skin surrounding the scar tissue became undermined, and flakes of crusty matter continued to peel off, now and then, along the course of the eruptions. The eruptions were very annoying, causing an almost intolerable itching, especially during the night, thus causing insomnia.

After having visited various clinics in Manila, where he was treated now and then with various kinds of ointment and lotion for a period of almost ten years, without avail, the patient came to the School of Hygiene and Public Health in October, 1931, to see if something could be done for him. Accordingly, biopsy was advised, and a piece of the affected skin was removed for sectioning. On examining the serial sections, a metazoan parasite, which answers well the description of *Demodex folliculorum* Simon, was found embedded in the hair follicles and sebaceous glands. Prof. William A. Riley, of Minnesota, who happened to be in Manila at the time, saw the sections and he opined that the parasite was most likely a *Demodex*. Efforts were made to tease out whole specimens for study, but all attempts failed.

HISTOPATHOLOGY

The inflammation set up by the invading parasites is essentially a chronic one. The epithelial cells surrounding the parasites appear apparently normal except those that are in immediate contact with the invaders, which are flattened and stretched out forming a kind of epithelial capsule. On closer examination, however, the basal and prickle cells appear markedly swollen or œdematous. They are widely separated from one another, thus rendering the fibrils which under normal condition compactly

bind them together very conspicuous. There is distinct hypertrophy of the epithelial cells. Strands of the proliferated epithelium often dip into the underlying stratum corium and loop out portions of the latter. Thus, islets of white fibrous and yellow elastic tissue appear to be scattered here and there within the epidermis. There is no evidence of round-cell infiltration, and eosinophiles and giant cells are not seen. The horny layer is greatly thickened (hyperkeratosis) ; it peels off in parts and often presents a dirty scaling mass, which in reality consists of dead hornified epithelial cells, and coagulated plasma that has been allowed to transude by the weakened basal and prickle cells. The affected sebaceous glands are often entirely destroyed and replaced by a deposit of cheesy matter (comedones). Study of the serial sections shows that the tunnels bored by the invading parasites communicate with the exterior.

There is no doubt that the invaders produce a considerable amount of irritation to the surrounding cells, which in the present case had been going on for almost ten years. If it is true, as has been repeatedly alleged, that certain forms of cancer are caused by irritants—chemical, mechanical, or parasitic—acting on the tissues for long periods, Borel's claim that *Demodex* is associated with the spread of cancer seems not to be so far fetched. In this connection it is worth while recalling the lecture of Professor Macleod, of the London School of Tropical Medicine and Hygiene, regarding the probable production of malignant growth in the skin, as follows:

> In the epidermis, the only cells that are concerned in reproduction are the basal cells dividing by karyokinesis. The daughter cells never divide under normal condition, but undergo metamorphosis or cornification. If the basal or mother cells are irritated mechanically or otherwise, they produce more daughter cells, and hence an excess of horn cells which are not cast off as rapidly as they are formed (hyperkeratosis of manual hands, corns). The irritant may come from outside, or it may be within the skin, or it may come from the circulating blood as in chronic arsenical poisoning. Arsenic, for instance, secreted by the sweat glands, permeates the epidermal cells, and stimulates the basal or mother cells to active division, resulting in excess of horny cells or hyperkeratosis. The daughter cells under abnormal conditions may be induced to multiply. Epithelioma of the skin has been known to develop as a result of arsenical poisoning.

While it is true that in the present case there is no evidence of malignancy in the tissues examined, the foregoing still suggests the possibility of cancer arising as a result of chronic irritation on susceptible tissues.

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TREATMENT

Owing to the fact that the follicle mites occur deeply in the skin, treatment with ointments proved useless. Penetrating materials, such as, benzine, 1 part, and olive oil, 4 parts, or application of tincture of oidine, have been tried by other authors, but the results seem unsatisfactory. Evidently, this organism needs very little air to maintain life, otherwise, by closing the openings of the tunnel in which it lives, as would have happened when ointments were applied on the affected skin, it would have died of suffocation. As the patient had been repeatedly treated for his condition with various kinds of ointment in the clinics and hospitals that he had visited for almost ten years without apparent improvement, it was deemed proper to resort to another method of treatment. The affected parts were exposed to daily ethyl chloride spray until blanched, the spray being continued for a further thirty or sixty seconds at each application. Each part was subjected to seven or eight applications. As the parts affected were quite extensive and as the patient could not stand extensive freezing at each sitting, it took more than forty-five days to cause the death of the parasites and the consequent healing of the lesions. The patient, who expressed genuine satisfaction at the result of this treatment, has not been seen nor heard from since, so that it is not known whether or not a recurrence has taken place.

SUMMARY

An arthropod answering the description of *Demodex folliculorum* Simon has been found associated with a rather severe and chronic dermatitis superimposed on the edges of healed mustard-gas lesions on the face. Biopsy has been performed and the histopathology of the lesions described. Treatment with ethyl chloride spray, which has been found previously to be effective in the treatment of various skin conditions due to metazoan parasites, has been instituted with remarkably favorable results.

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2. CASTELLANI, A., and A. J. CHALMERS. Manual of Tropical Medicine, 2d ed. William Wood and Company, New York.
3. HERMS, W. B. Medical and Veterinary Entomology, 2d ed. The Macmillan Company, New York (1923).

ILLUSTRATIONS

Plate 1

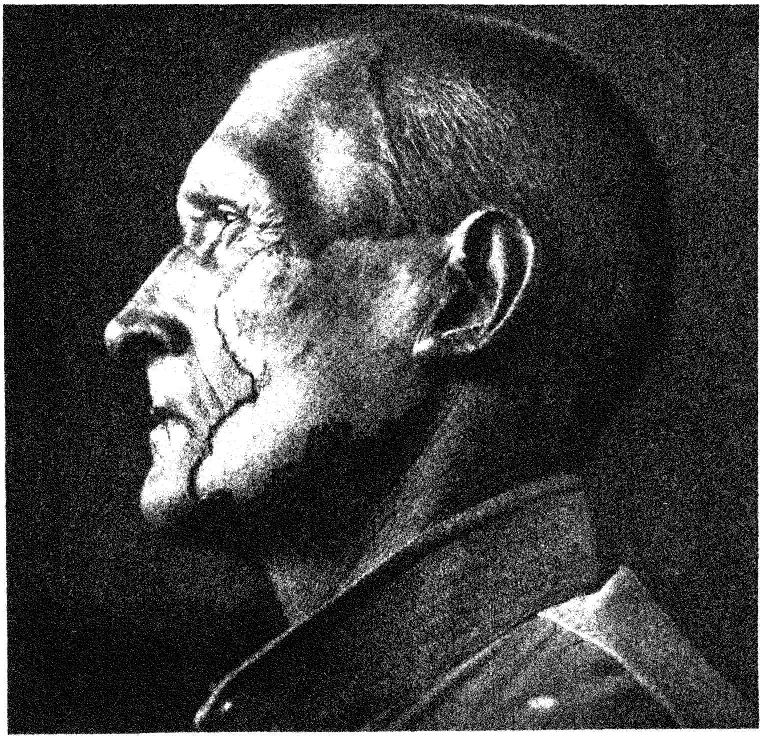
Fig. 1. The case of facial dermatitis, showing the extensive scar originally caused by mustard gas. The raised, undermined skin at the margin of the scar tissue marks the site of the infestation with the arthropod.

2. A tangential section of the invading arthropod in the hair follicle. Note the mild tissue reaction. $\times$ 200.

Plate 2

Fig. 1. A cross section of the parasite in the abdominal region. $\times$ 150.

2. A section of the parasite near the head region. $\times$ 150.



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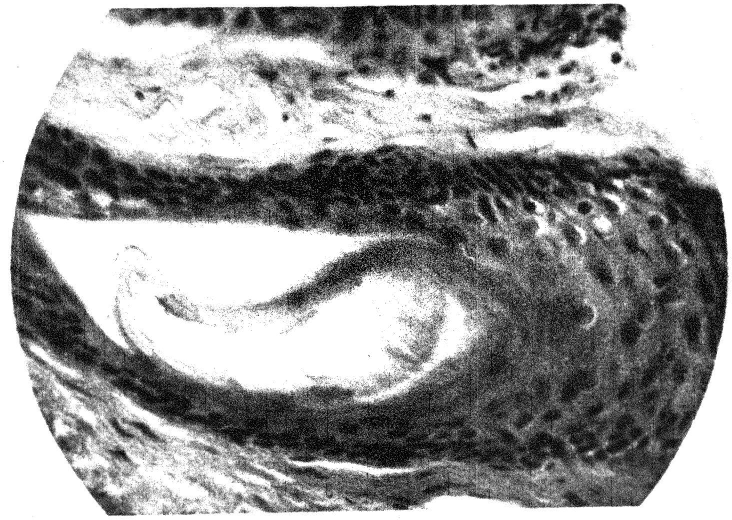

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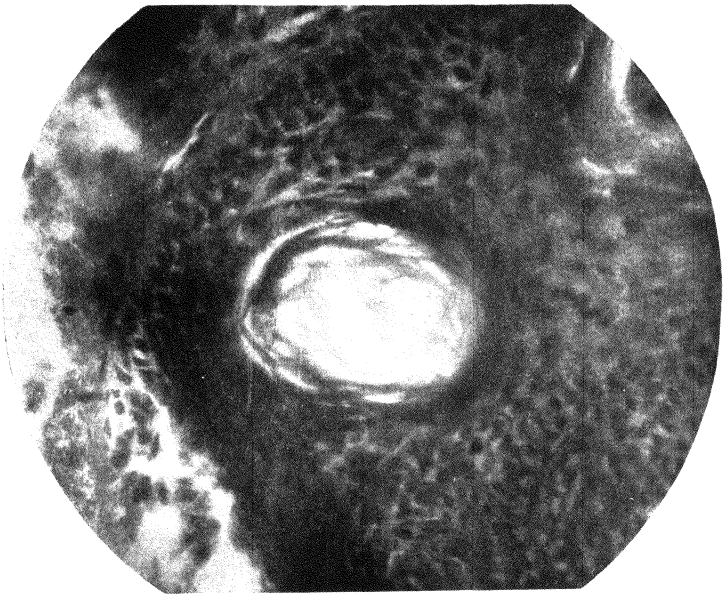
PLATE 1.



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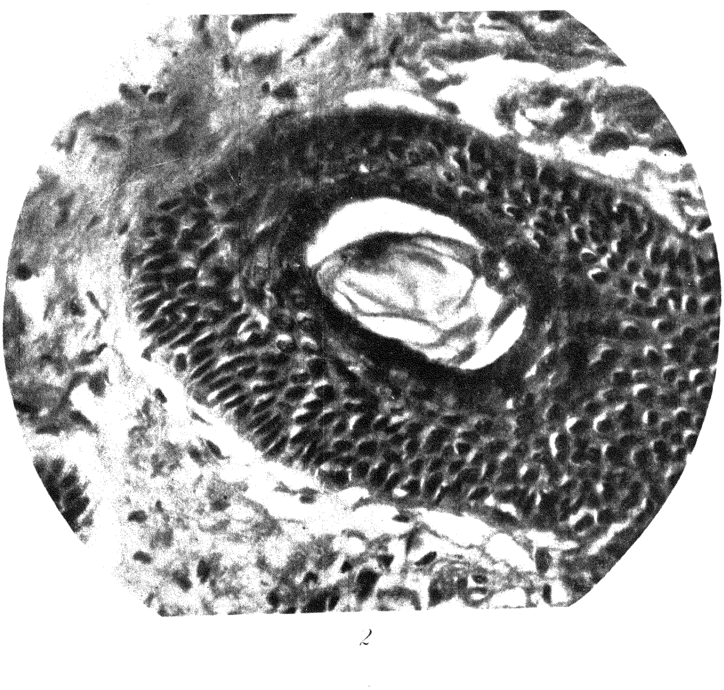

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PLATE 2.

THE PHILIPPINE BUREAU OF SCIENCE

MONOGRAPHIC PUBLICATIONS

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THE PHILIPPINE JOURNAL OF SCIENCE

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BLOSSOM-BLIGHT OF MANGOS IN THE PHILIPPINES

By F. B. SERRANO [1]
Plant Pathologist, Bureau of Science, Manila

and

M. A. PALO
Junior Mycologist, Bureau of Science, Manila

SEVENTEEN PLATES

INTRODUCTION

Blossom-blight of the mango, *Mangifera indica* Linnæus, caused by the hoppers *Idiocerus clypealis* Léthierry and *I. niveosparsus* Léthierry, is so far the most destructive and most common pest of mangos known in the Philippines. It has been observed to attack all the different varieties of mango; such as, carabao, pico, señora, and many other unidentified hybrids. All of these varieties seem to be equally susceptible to the infestation under more or less identical conditions. The pahutan, *Mangifera altissima* Blanco, which is taken by many people as

[1] The writers wish to express their appreciation to Dr. W. H. Brown, director of the Bureau of Science, for his valuable suggestions and criticisms during the progress of the work; to Messrs. G. Bellosillo and F. del Rosario, assistant systematic entomologists, Bureau of Science, for studying the life history of the hoppers; and to Dr. José Paterno, manager of Hacienda Madrigal at Muntinlupa, Rizal Province, Luzon, for extending his kind coöperation in supplying part of the labor and other help while the work was in progress at Muntinlupa. The writers are also indebted to Dr. E. Quisumbing, acting chief of the division of botany, Bureau of Science, for reading the manuscript.

a variety of mango, is attacked by the same pest but, for some reason or other, it does not seem to suffer therefrom no matter how severe the infestation may be.

This pest has been reported in Batangas, Cavite, Laguna, Rizal, Bulacan, Bataan, Zambales, Pampanga, Tarlac, Nueva Ecija, and Pangasinan Provinces. While the northern provinces of Luzon, the Bicol Provinces, the Visayan Islands, and Mindanao and Sulu Archipelago have not been surveyed, it seems highly probable that the same pest will be found in some if not all of those localities judging from its severity and distribution in and around Manila. Whether or not it is indigenous to the Islands is unknown.

There is no doubt that it is gaining ground and becoming more serious, especially in Bulacan, Cavite, and Rizal Provinces. Growers are more or less unanimous in the belief that ten or twenty years ago this pest was not as severe as it is now. The data in Table 1, from an actual survey conducted by the writers in May, 1932, serve to show the seriousness of the situation.

TABLE 1.—*Total percentage of infestation by the blossom-blight hoppers, Idiocerus clypealis and I. niveosparsus, in each province surveyed.*

Province.[a]	Trees examined.	Hoppers.	Infested trees.			
			Light.	Moderate.	Severe.	Total.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Cavite	131	I. C.	28.25	17.56	54.19	100.00
		I. N.	8.39	8.39	3.05	19.84
Bulacan	143	I. C.	20.28	22.37	53.14	95.70
		I. N.	20.97	8.39	4.19	35.56
Rizal	1,556	I. C.	37.01	34.64	21.84	93.50
		I. N.	49.74	23.20	3.85	76.80
Average		I. C.	35.08	32.45	26.61	94.15
		I. N.	44.42	20.76	3.93	69.12

[a] The following municipalities were covered by this survey: Cavite Province: Bacoor, Imus, Dasmariñas, Noveleta, Caridad, San Roque. Bulacan Province: Meycauayan, Marilao, Bigaa, Guiguinto, Quingua, Pulilan, Baliuag. Rizal Province: Las Piñas, Muntinlupa.

It may be seen from Table 1 that of 1,830 trees examined, 94.15 per cent showed infestation by *Idiocerus clypealis* and 69.12 per cent by *I. niveosparsus,* indicating that the former is preponderant. Disregarding the infestation due to *I. niveosparsus,* which is already included in the figures for *I. clypealis,* and considering that four-fifths of the flowers with the average

infestation of 94.15 per cent were totally damaged by the hoppers while the rest survived, which is a very conservative estimate based on actual observations in the field, the total mango crop actually harvested in the three provinces covered by the survey represented but 24.68 per cent of what it should really have been if there were no infestation at all.

In Manila and suburbs like Santa Mesa and Santa Ana there was a moderate to severe infestation by the hoppers in February, 1932, causing a total destruction of the inflorescences in many cases. From all indications, however, the greatest damage done to the mango crop in that season was in Pasay and Novaliches, Rizal Province. Practically all of the trees, about two hundred in the municipality of Pasay, bloomed profusely in January, 1932; but owing to the devastation caused by the hoppers, particularly *I. niveosparsus,* no mango crop to speak of was harvested the following summer. Similarly, it is said that in the hacienda of Dr. N. Jacinto in Novaliches one hundred trees, which were smudged [2] in November and December, 1931, all bloomed profusely, but the crop was practically a total loss owing to the ravages of this pest.

Again, it was learned from the mango growers in Muntinlupa, Rizal Province, that sometime in 1910, prior to the outbreak of this pest, their mango trees generally were so heavily laden with fruits that there were times when they could not pick them all. But now the crop they generally get does not even suffice to cover the expenses incurred in smudging. The existing condition is so disheartening that, unless something is done by the Government to aid the growers, the total yearly output of mangos may suffer a further decrease.

Numerous inquiries from growers all over the mango-producing sections where the hoppers are present seem to indicate that the pest really is an all-important problem and warrants a more careful and exhaustive study than it has been accorded heretofore. The life history and habits of the hoppers need to be investigated more thoroughly; for, unless these are clearly understood, control measures can only be empirical.

[2] "Smudging" or "smoking" is a process of forcing the mango to flower early or before the usual season, by burning trash with green weeds or green leaves and branches of shrubs or trees under the mango trees generally during the whole day for from seven to ten or more consecutive days. This is a common practice in nearly all the mango-growing sections of the Archipelago.

All of this, together with the great economic importance of the pest, considering that the mango is admittedly the premier dessert fruit in the Philippines, made a new investigation of this problem necessary. This paper covers mainly the results of the spraying experiments that have been finished so far, together with an enumeration of other miscellaneous factors that were observed to be more or less intimately associated with the reduction of mango yield. Some new facts have been discovered that give rise to advice which, if followed, would help the growers save much of their mango crop.

HISTORICAL REVIEW

As far back as 1845 Blanco,(1) in his Flora de Filipinas, referred to mango failure. However, he did not state the cause of such failure, although the common belief among the natives, that when rain is abundant the mango crop is poor and the rice crop plentiful, was viewed by him with approval. It was not explained, however, how rain was inimical to the mango. It is possible that the occurrence of the blossom-blight pest dates back as far as the early Spanish régime.

The available literature on the subject indicates that little work has been done on this pest in the Philippines. It was first reported by Wester(2) as causing damage to the mango crop in Bataan and Cavite Provinces in April, 1911. In 1924, the Bureau of Agriculture(3) reported the great damage done to the mango blossoms in the Islands.

Although apparently present and very destructive before, no serious attention was paid to it until March, 1930, when Palo(4) found the same pest to have greatly contributed in causing enormous losses to the crops in practically all the mango-growing sections around Manila, particularly in Bulacan and Rizal Provinces. He also found other factors contributing to the reduction of the mango crop, such as the anthracnose caused by the *Gloeosporium* stage of *Glomerella cingulata* (Stonem.) S. and v. S., and the tip-borer, caused by *Chlumetia transversa* Walker. In his spraying experiments in 1931, he used Bordeaux-nicotine-lead arsenate combination in addition to nicotine-soap, and showed that this treatment could increase the yield of the treated trees many times over that of the control.

In 1930, Ramachandra Rao(5) reported that the hoppers with mildews and other insect pests were reducing the mango crop

in southern India. He found *Idiocerus niveosparsus* to be more destructive than *I. clypealis*. The first attempt he made at spraying to control this pest was in Chittoor District in 1913. A preliminary spray with Bordeaux mixture followed by fish-oil-resin soap was found by him to be effective in minimizing the ravages of the pests.

Wagle(6) reported in May, 1928, that the hopper *Idiocerus niveosparsus* and a mildew of the genus *Erysiphe* were partly responsible for the shedding of mango flowers and fruits in Ratnagiri and Thana Bombay Presidency, India. He found Bordeaux-mixture spray effective for the mildew, increasing the percentage of maturing fruits by 21 per cent in one instance and by 230 per cent in another. In the presence of hoppers he found that spraying with fish-oil-soap solution increased the yield of fruits by 62 per cent. A combination of the two sprays was not effective even against hoppers.

DESCRIPTION OF THE MANGO FLOWER

The flower of the mango has been the subject of many investigations, and several descriptions of it in detail were published recently. The present description deals only with its growth in relation to the period of hopper infestation and the percentage of perfect flowers, which many believe has a direct correlation with production. The two leading local varieties, the carabao and the pico, were used for this determination.

The mango inflorescence contains both hermaphrodite, or perfect, flowers and staminate, or male, flowers. Popenoe(7) states that each panicle carries from 200 or 300 to more than 4,000 flowers, of which only 2 to 3 per cent are perfect in some varieties, and as many as 60 to 75 per cent in others. He found the Philippine varieties to have in general more perfect flowers than staminate flowers.

Wagle(6) has found that the percentage of perfect flowers varies with the different flower flushes from the same tree, with the flowers from the same tree at different seasons, and with the flowers from different varieties, but not with flowers from individual trees of the same variety. This variation, if true, might have been the reason why the percentage of perfect flowers of carabao and pico varieties, while relatively high, as shown in Table 2, was found not to exceed 50 per cent in either case, which is contrary to the report of Popenoe.(7) Table 2 represents a summary of the study made on twenty trees on

the basis of five panicles per tree. This was conducted in February, 1932, in Bayanan, Muntinlupa, Rizal Province.

TABLE 2.—*Percentage of perfect flowers of carabao and pico varieties.*

Carabao.		Pico.	
Tree No.	Perfect flowers.	Tree No.	Perfect flowers.
	Per cent.		*Per cent.*
1	54.5	12	30.0
2	43.0	13	24.7
21	41.0	15	26.6
24	47.4	22	26.6
27	47.7	25	19.4
28	46.3	30	30.3
40	41.1	34	50.0
44	48.0	36	13.7
55	40.0	41	22.0
56	49.0	45	24.4
70	48.0	52	23.0
75	39.3	60	13.0
Average	45.2	Average	25.3

As shown in Table 2, the carabao variety has on the average 45.2 per cent perfect flowers, and the pico variety only 25.3 per cent. Whether or not carabao is the better yielder of the two owing to its higher percentage of perfect flowers, will be discussed under the spraying experiments.

It was thought necessary to have an idea of the relative average daily growth of the mango inflorescence in relation to hopper infestation and its control. One healthy-looking carabao tree about 40 years old, with the inflorescence buds just emerging from their protective covering, was selected for this purpose. Twenty of such buds were tagged and the growth of each was measured every other day until the twenty-third day when all of them ceased to grow. The results of these observations are given in Table 3.

It may be seen from Table 3 that the average daily growth of carabao mango inflorescence gradually increases from the day the panicle emerges from the bud to about the tenth or eleventh day, when it reaches the maximum, and then gradually decreases, until about the twenty-first day, when all the flower buds have expanded and full development has been attained. The flower buds on the basal portion are generally the first to

open, beginning the thirteenth day or thereabout. By the time the flowers on the apices of the lateral branches and spikelets have completely opened and the panicle has ceased to grow, the staminate and other unfertilized flowers on the basal portion of the inflorescence begin to wither and fall, while the fertilized perfect flowers are just beginning to set fruits.

TABLE 3.—*Relative average growth of carabao mango inflorescence.*

Date observed.	Average of 20 panicles.	
	Length.	Growth.
1932	*cm.*	*cm.*
March 31	1.0	----------
April 2	1.7	0.7
April 4	3.5	1.8
April 6	7.3	3.8
April 8	14.4	7.1
April 10	22.9	8.5
April 12	28.4	5.5
April 14	31.9	3.5
April 16	32.8	0.9
April 18	33.4	0.6
April 20	33.6	0.2
April 22	33.6	Nil.
April 24	33.6	Nil.

DESCRIPTION OF THE BLOSSOM-BLIGHT

As the name implies, mango "blossom-blight" is the blighting or withering of the inflorescences of mangos, before or after the opening of the flower buds, resulting from the infestation by the two species of mango leaf-hoppers, *Idiocerus clypealis* and *I. niveosparsus.*

The name "blossom-blight" was chosen for this pest to distinguish it from other common names like mango-blight, mildew, and anthracnose caused by the *Gloeosporium* stage of *Glomerella cingulata* (Stonem.) S. and v. S. The term "mango-hoppers," as used by Ramachandra Rao(5) and Palo(4) for the same pest, sounds rather ambiguous and misleading in as much as in the Philippines there are five or six kinds of hoppers feeding on mango, only two of which are responsible, either singly or jointly, for the destruction of the flowers in so far as the writers' observations and findings are concerned. Therefore, naming this pest simply "mango hopper" may include all of them. On the other hand, "blossom-blight" stands for one

definite object, denoting a characteristic blighting of the blossom, hence the name (Plate 2, figs. 1 and 2).

The mango blossom-blight may manifest itself in about ten to twenty days or more from the date of the outbreak, depending on the volume of infestation and age of the inflorescence when the eggs are laid. The adult hoppers begin to lay eggs soon after the inflorescence buds have appeared and the tender panicles have grown to a length of 2 to 4 centimeters. Egg punctures may be noted in the flower stems and buds immediately after the occurrence of the first infestation. Early outbreak coupled with profuse egg-laying of the hoppers may cause the inflorescence to wither and drop before the opening of the flowers is completed (Plate 3, figs. 1 and 2). When this occurs the crop is doomed (Plate 4, fig. 1). There are cases, however, where the infestation is neither as early nor as heavy as this, thereby allowing some fruits to set and develop to maturity (Plate 4, fig. 2).

When the eggs hatch the young ones feed on the inflorescence by piercing the tissues with their proboscis and sucking the juice from them. In severe outbreaks the nymphs may occur in hundreds on a single inflorescence and cause blighting of the flowers after a few days. When the infested inflorescence is agitated violently the nymphs on the flowers may be seen moving downward to hide on the lower parts of the twigs and the nether sides of the leaves (Plate 5, figs. 1 and 2).

The hoppers may damage the mango crop in two distinct ways: first, owing to the heaviness of egg-laying, physical injury is inflicted on the flower stems as well as on the individual flower buds, thereby causing them to wither and drop; and second, the nymphs that hatch in large numbers crowd together among the florets and, with their proboscis, pierce the tissues of the flower stems and draw the sap. Most of the sap thus sucked is excreted after a certain amount of digestion as droplets of sticky, sweetish fluid commonly known as "honey-dew." In severe cases of infestation not only the inflorescences, leaves, and branches of the tree, but also the plants and the ground below may be found covered with a fairly thick incrustation of this fluid. When the weather is dry the honey-dew dries into a transparent, shiny, yellow deposit, and if there be some rainfall or even a heavy fall of dew, it serves as a rich medium for the growth of sooty mold, *Chaetothyrium mangiferae* Mendoza, which is more or less constantly associated with blossom-blight.

Abundant growth of this mold on a mango tree may, therefore, be an indication that there had been a severe hopper infestation on that tree.

DESCRIPTION OF THE HOPPERS

SYSTEMATIC POSITION

Palo(4) reported that Dr. L. B. Uichanco, professor of entomology in the College of Agriculture, University of the Philippines, identified these two species of hoppers causing mango blossom-blight, as follows:

Order Homoptera; family Cicadellidæ; subfamily Bythoscopenæ.

1. *Idiocerus niveosparsus* Léthierry. This is the large brown species, about 4.5 mm long.
2. *Idiocerus clypealis* Léthierry. A much smaller species, only about 3.5 mm long, ground color, light greenish.

NAMES OF THE INSECTS

The large species is *Idiocerus niveosparsus* Léthierry, and the small species *I. clypealis* Léthierry. There is no local name that fittingly describes these insects, although in Tagalog regions they are sometimes called "kuliglig-maliit," or "hanip." "Hanip" is more commonly used because the newly hatched *Idiocerus clypealis*, which is the commoner of the two species, looks much like a mite. "Hanip" is the Tagalog word for mite.

LIFE HISTORY

The life history of the two species of mango blossom-blight hoppers was studied in Muntinlupa, Rizal Province, from April to May, 1932. This experiment was carried out in the following manner:

Twelve uniform about-to-open inflorescence buds were selected and each was inclosed in a celluloid cylinder 52 centimeters long and 22 centimeters in diameter, with cheese-cloth covers at both ends, taking the necessary precaution so that no insects, to begin with, were inclosed in the cages (Plate 6, figs. 1 and 2). After six days when the inflorescences had grown to a certain length a pregnant hopper (*Idiocerus clypealis*), with a large protruding abdomen, was introduced in each of the twelve cylinders and allowed to remain for twenty-four hours during which period oviposition was observed. At the termination of twenty-four hours all of the hoppers were released. After the fourth day, upon agitating the panicles, the young ones began to come out as tiny ivory-yellow nymphs measuring a fraction

of a millimeter. Daily observations were continued, the period of each molt being noted. After nine to ten days the nymphs were found to have molted four times, eventually becoming adults (Plate 1, figs. 1 to 6).

The same procedure was followed in studying the second species, *Idiocerus niveosparsus,* which was found to have five nymphal stages (Plate 1, figs. 8 to 14). The results of these two series are given in Table 4.

TABLE 4.—*Life history of the mango blossom-blight hoppers.*

Species.	Incubation period.	Stage.						Total span from egg to adult.
		First.	Second.	Third.	Fourth.	Fifth.	Nymphal.	
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
Idiocerus clypealis	4.5	1.9	2.0	2.2	3.5		9.6	14.1
Idiocerus niveosparsus	4.1	1.1	1.2	1.2	1.7	2.2	7.4	11.5

When the tests were conducted on detached inflorescences suspended in vials with cheese-cloth covers and water to keep the flowers fresh under laboratory conditions, the life cycle was lengthened by several hours. This would seem to indicate that the supply of food as well as the environmental conditions; that is, temperature and moisture, play their rôles in the life history and habits of these hoppers.

THE NYMPHS

Idiocerus clypealis.—As may be seen from Table 4 there are but four nymphal stages credited to this species. The first stage measures about 0.75 millimeter long, and is ivory-yellow turning cream-buff, then vinaceous-fawn.[3] Some nymphs may be olive-ocher or bluish black with a cream stripe when they pass to the second and third stages. The nymph increases in size gradually as it grows from one stage to the next until it reaches about 3.5 millimeters in length when it molts for the last time and becomes an adult (Plate 1, figs. 2 to 5). The time interval of molting seems to increase as the nymph grows older. On the average the nymphal stage covers about nine days fourteen hours.

[3] The colors indicated here and elsewhere in this paper are those of Ridgway's Color Standards and Color Nomenclature. Washington (1912).

It may be of interest to mention that the exuviæ of the first three nymphal stages may be found among the flowers, while the fourth and last exuvia may be seen stuck in the natural position on the lower surface of the leaves below the panicle. If there are new leaf flushes on the tree practically all of the fourth exuviæ will be found there, owing perhaps to the fact that the last nymphal stage of this hopper seems to prefer seclusion under those leaves (Plate 7, figs. 1 and 2).

Idiocerus niveosparsus.—Unlike the first species there are five nymphal stages credited to *Idiocerus niveosparsus.* Ramachandra Rao(5) and Wagle,(6) on the other hand, reported but four for both.

The first stage measures about 1 millimeter long, and is pale sky gray turning vinaceous-lilac, then brownish drab to dusky drab. The eyes are neutral red at first, turning taupe brown later. The nymph gradually increases in size as it grows older from one stage to the next until it reaches 4.5 millimeters long when it molts for the fifth time to become an adult (Plate 1, figs. 9 to 13). As in *Idiocerus clypealis* the time interval of molting seems to increase as the nymph grows older, although it is considerably shorter in this case. On the average the nymphal stage covers about seven days ten hours, which is more than two days shorter than that of *Idiocerus clypealis.*

The exuviæ of this species may be found with difficulty, generally among the flowers and occasionally on the lower surface of the leaves. Unlike *Idiocerus clypealis* the last nymphal stage of this species does not seem to select a special place in which to deposit the exuviæ; hence, the difficulty in locating them.

THE ADULTS

The adults of both species are wedge-shaped. They can move about and fly from flower to flower, leaf to leaf, or even tree to tree. They like cool, sheltered places, hence they are more abundant in thick growths with heavy shade than in open places. Like the nymph, the adult has a proboscis with which it sucks plant juice; which, after some digestion, it excretes in droplets of sweet sticky fluid commonly known as "honey-dew." Both species may be found together in the same inflorescence or in the same tree, with *Idiocerus clypealis* generally preponderant at the beginning, but gradually losing ground until eventually *I. niveosparsus* gains the upper hand. This eventual preponderance of *I. niveosparsus* when both species occur in a tree, is

due, perhaps, not to the latter's physical superiority over the former, but to the fact that as soon as the flowers begin to wither *I. clypealis,* unlike *I. niveosparsus,* cannot lay its eggs any more, hence it moves to adjacent trees in search of fresh materials. Upon approaching a tree with many adult hoppers one will hear a cricking noise caused by their flight from leaf to leaf.

Idiocerus clypealis.—The adults of this species are cinnamon-drab with white spots just behind the head. The female is 4 millimeters and the male 3.8 millimeters long (Plate 1, fig. 6).

Unlike the other species *Idiocerus clypealis* lays its eggs in the flower buds only (Plate 1, fig. 1) and has not been observed to copulate after the blooming season is over even in the presence of suitable feed like the flower flushes produced by smudging. The reason for this is not known.

Idiocerus niveosparsus.—The adults are dusky-drab with light stripes on the wings. The female is a little larger than the male, measuring $5\frac{1}{6}$ millimeters in length, while the male is 5 millimeters (Plate 1, fig. 14).

During the mango flowering season this species also feeds on the sap of the inflorescence and lays its eggs in the axis of the flower heads, in the flower buds and in the flower stems (Plate 1, fig. 8). During the offseason it generally feeds on the new leaf flushes and lays its eggs in the tender midribs of the young leaves, usually on the lower side.

THE EGGS

Idiocerus clypealis.—The eggs of this species are usually in pairs, cream colored, cigar-shaped, tapering at one end and slightly round at the other (Plate 1, fig. 1). They are about 0.75 millimeter long and 0.1 millimeter thick. They hatch in about four and one-half days, so that, with the nymphal stage being completed in about nine and one-half days, the whole life history from the laying of the eggs to the emergence of the adult hopper is about fourteen days.

Idiocerus niveosparsus.—The eggs of this species are ivory-cream, cigar-shaped, tapering at one end and slightly round at the other (Plate 1, fig. 8). They are about 1.2 millimeters long and 0.3 millimeter thick. To the tapering end is attached a white woolly covering perhaps to protect the eggs from desiccation, this end being partly exposed. They hatch in a little over four days so that, with the nymphal stage being completed

in about seven and one-half days, the whole life history from the laying of the egg to the emergence of the adult hopper is completed in about eleven and one-half days, or two and one-half days less than that of *I. clypealis*.

SEASONAL ACTIVITIES

Both species of mango-blight hoppers, *Idiocerus clypealis* and *I. niveosparsus*, seem to be most active during the flowering season; that is beginning December or even as early as October and November, if the trees are smudged, until April when the flowers begin to wither. During these months the hoppers feed on and lay eggs in the mango inflorescences. As soon as the mango flowers wither and fall the hoppers are less conspicuous. However, examination of the mango trees will reveal the hoppers although they are fewer in number. This has been shown by the survey made in Pasay, Rizal Province, July 15 and 16, 1932, the results of which are given in Table 5.

TABLE 5.—*The relative abundance of the blossom-blight hoppers, Idiocerus clypealis and I. niveosparsus, on the carabao and pico varieties of mango during the season when there are neither flowers nor fruits. (Surveyed July 15 and 16, 1932, at Pasay, Rizal Province.)*

Trees examined.	Hoppers.	Infested trees.			Total.
		Few.	Moderate.	Abundant.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Carabao-170	I. C.	38.23	59.41	1.17	98.82
	I. N.	32.94	0	0	32.94
Pico-205	I. C.	44.39	53.66	1.95	100.00
	I. N.	42.43	0	0	42.43

It seems that these hoppers can live on the mango leaves in the absence of the flowers. Only *Idiocerus niveosparsus*, however, was found copulating and laying eggs during the off-season, although somewhat limited in extent. The eggs are laid in the midribs of tender leaves, generally on the lower surface.

Now comes the question as to whether or not both species can live on plants other than the mangos. A search for such plants around Muntinlupa from February to May, 1932, ended in vain. It was not until June, 1932, after all the mango flowers had withered and dried, that some of such plants appeared suspicious. Uphill at the Hacienda Madrigal in Muntinlupa the adults of *Idiocerus clypealis* were found resting on the leaves

of madre cacao, *Gliricidia sepium* (Jacq.) Steud.; sineguelas, *Spondias purpurea* Linn.; and guava, *Psidium guajava* Linn. In Pasay, as shown by the survey conducted July 15 and 16, 1932, adults of *Idiocerus clypealis* were found on fourteen plants besides the mangos, as follows:

Breadfruit; *Artocarpus communis* Forst.
Jackfruit; *Artocarpus integra* (Thunb.) Merr.
Achuete; *Bixa orellana* Linn.
Tampoy; *Eugenia jambos* Linn.
Chinese litchi; *Litchi sinensis* Sonn.
Guanabano; *Anona muricata* Linn.
Gumamela; *Hibiscus rosasinensis* Linn.
Sampaguita; *Jasminum sambac* (Linn.) Ait.
Alagao; *Premna odorata* Blanco.
Anonang; *Cordia dichotoma* Forst. f.
Balimbing; *Averrhoa carambola* Linn.
Calamondin; *Citrus mitis* Blanco.
Santol; *Sandoricum koetjape* (Burm. f.) Merr.
Lucban; *Citrus decumana* Murr.

The following experiment was laid out to determine whether or not the plants above mentioned serve as intermediary hosts to *Idiocerus clypealis:* Nineteen cages of celluloid cylinders with cheesecloth covers at both ends, similar to those employed in the study of the life history of the hoppers, were fixed. The first cage was suspended under the shade of a mango tree after fifty adults of *I. clypealis* had been introduced into it without anything to eat, while the remaining eighteen were set out and distributed, one by one, under shade among the same number of plants above named including mango, each inclosing the same number of adults with a twig of each of the corresponding plants undetached for the hoppers to feed on. Daily observation was made for a month, and the daily rate of mortality in each cage was noted. Table 6 gives the results obtained.

The results shown in Table 6 seem to indicate that *Idiocerus clypealis* cannot live over three days if left alone with nothing to eat; that it can partly live on various plants which apparently serve as intermediary hosts; and that if necessary it can feed on almost any kind of plant and live for some time, depending on the suitability of the feed. This peculiarity of *I. clypealis*, which is not found in *I. niveosparsus*, may serve as a working hypothesis for explaining why the former seems to outlive the latter.

PARASITISM

Like most other insect pests, the mango blossom-blight hoppers have some natural enemies of their own. The adults of *Idiocerus clypealis* have been observed to be affected by a fungous parasite, which is being studied. This fungus seems to be capable of attacking and killing the insects, pasting them firmly with the brown, matted, mycelialike filaments on the lower surface of the mango leaves as well as on the leaves of the intermediary hosts (Plate 8, figs. 1 and 2). This is, by the way, further strong evidence showing that when there are no mango flowers the hoppers live, at least partly, on other host plants. However, it has not been observed to attack the nymphs of either species or the adults of *I. niveosparsus.* Circumstantial evidence seems to indicate that this fungus, like most other fungi, is not favored by dry weather and, hence, does not seem to be active during summer. This may explain why no infections were found during the blooming season.

Subramaniam (8) has found the mango leaf-hoppers (*Idiocerus* spp.) in India to be parasitized by a pipunculid fly, *Pipunculus annulifemur* Brun.; a stylopid parasite, *Pyrilloxenos compactus* Pierce; an epipyropid moth, *Epipyrops fuliginosa* Tams.; and a dryinid wasp.

There are more than twenty predators[4] feeding wholly or partially on the nymphs. The following are some of those that have been observed actually feeding on the nymphs and eggs of the mango blossom-blight hoppers: The larvæ of three lady-bird beetles, *Nida billardieri* Crorch, *Epilachna punctata* Fabr., and *Coccinilla octamaculata* Fabr.; a medium-sized black ant, *Dolichoderus bituberculatus* Magr.; a medium-sized brown ant, *Tapinoma melanocephalum* Fabr.; a tiny brown ant, *Monomorium destructor* Jerdon; and a score or more kinds of spiders. The last-named ant was observed especially active in burrowing and eating the eggs from egg punctures of *Idiocerus niveosparsus.*

The importance of these predators and parasites, particularly the fungous parasite, as biological controls of the mango blossom-blight hoppers should be investigated.

[4] Identified by Messrs. Fidel del Rosario and Gervasio Bellosillo, assistant systematic entomologists of the Bureau of Science.

TABLE 6.—*Percentage mortality of adult Idiocerus clypealis in cages with and without feed to live on, based on fifty individuals.*

Food plant.	July, 1932.																
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1. None	0	14	60	100	----	----	----	----	----	----	----	----	----	----	----	----	----
2. Mango; *Mangifera indica* Linn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Madre cacao; *Gliricidia sepium* (Jacq.) Steud	0	0	20	40	50	58	66	66	72	80	88	90	96	96	100	----	----
4. Sineguelas; *Spondias purpurea* Linn	0	0	22	42	56	68	70	74	82	90	90	94	100	----	----	----	----
5. Guava; *Psidium guajava* Linn	0	0	4	10	10	14	34	54	66	100	----	----	----	----	----	----	----
6. Breadfruit; *Artocarpus communis* Forst	0	0	0	0	0	0	0	0	4	8	20	40	60	84	88	88	92
7. Jackfruit; *Artocarpus integra* (Thunb.) Merr	0	0	0	0	6	10	30	30	42	50	56	64	74	78	92	94	96
8. Achuete; *Bixa orellana* Linn	0	4	4	4	32	52	56	58	64	72	78	78	86	100	----	----	----
9. Tampoy; *Eugenia jambos* Linn	0	0	0	0	20	28	36	42	54	68	68	72	78	80	80	84	84
10. Chinese litchi; *Litchi sinensis* Sonn	0	0	0	0	0	0	8	18	22	30	34	38	44	46	50	64	72
11. Guanabano; *Anona muricata* Linn	0	0	0	0	14	34	34	38	42	68	80	82	84	88	92	94	94
12. Gumamela; *Hibiscus rosasinensis* Linn	0	0	0	0	0	20	28	34	38	46	64	70	78	82	84	88	92
13. Sampaguita; *Jasminum sambac* (Linn.) Ait	0	0	24	26	32	38	46	48	56	62	68	76	86	94	100	----	----
14. Alagao; *Premna odorata* Blanco	0	0	0	16	24	34	40	46	50	70	80	84	88	90	92	96	100
15. Anonang; *Cordia dichotoma* Forst. f	0	0	0	0	0	0	4	8	20	40	60	84	88	88	92	94	98
16. Balimbing; *Averrhoa carambola* Linn	0	4	6	10	26	42	60	64	76	88	92	96	100	----	----	----	----
17. Calamondin; *Citrus mitis* Blanco	0	22	26	30	44	64	74	82	88	90	98	100	----	----	----	----	----
18. Santol; *Sandoricum koetjape* (Burm. f.) Merr	0	6	8	12	18	28	32	36	48	72	88	90	92	100	----	----	----
19. Lucban; *Citrus decumana* Murr	0	18	26	40	68	78	82	86	92	96	96	98	100	----	----	----	----

Food plant.	August, 1932.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. None	----	----	----	----	----	----	----	----	----	----	----	----	----
2. Mango; *Mangifera indica* Linn	4	8	14	14	14	14	14	14	20	24	32	32	40
3. Madre cacao; *Gliricidia sepium* (Jacq.) Steud	----	----	----	----	----	----	----	----	----	----	----	----	----
4. Sineguelas; *Spondias purpurea* Linn	----	----	----	----	----	----	----	----	----	----	----	----	----
5. Guava; *Psidium guajava* Linn	----	----	----	----	----	----	----	----	----	----	----	----	----
6. Breadfruit; *Artocarpus communis* Forst	92	92	96	100	----	----	----	----	----	----	----	----	----
7. Jackfruit; *Artocarpus integra* (Thunb.) Merr	96	100	----	----	----	----	----	----	----	----	----	----	----
8. Achuete; *Bixa orellana* Linn	----	----	----	----	----	----	----	----	----	----	----	----	----
9. Tampoy; *Eugenia jambos* Linn	88	96	100	----	----	----	----	----	----	----	----	----	----
10. Chinese litchi; *Litchi sinensis* Sonn	74	80	92	94	98	100	----	----	----	----	----	----	----
11. Guanabano; *Anona muricata* Linn	98	100	----	----	----	----	----	----	----	----	----	----	----
12. Gumamela; *Hibiscus rosasinensis* Linn	92	92	100	----	----	----	----	----	----	----	----	----	----
13. Sampaguita; *Jasminum sambac* (Linn.) Ait	----	----	----	----	----	----	----	----	----	----	----	----	----
14. Alagao; *Premna odorata* Blanco	----	----	----	----	----	----	----	----	----	----	----	----	----
15. Anonang; *Cordia dichotoma* Forst. f	98	100	----	----	----	----	----	----	----	----	----	----	----
16. Balimbing; *Averrhoa carambola* Linn	----	----	----	----	----	----	----	----	----	----	----	----	----
17. Calamondin; *Citrus mitis* Blanco	----	----	----	----	----	----	----	----	----	----	----	----	----
18. Santol; *Sandoricum koetjape* (Burm. f.) Merr	----	----	----	----	----	----	----	----	----	----	----	----	----
19. Lucban; *Citrus decumana* Murr	----	----	----	----	----	----	----	----	----	----	----	----	----

INFESTATION EXPERIMENT

To ascertain the relative destructiveness of the two species of mango hoppers, *Idiocerus clypealis* and *I. niveosparsus*, the following experiment was conducted in April, 1932, in Muntinlupa, Rizal Province, Luzon.

Forty uniform about-to-open inflorescence buds on a pico mango tree were caged each in a celluloid cylinder 52 centimeters long and 22 centimeters in diameter with cheese-cloth covers at both ends, taking precautions that no insects, to start with, were present in the inclosure. These cages were grouped into five series of eight cylinders each. On the fifth day, or four days after the opening of the inflorescence buds, 17 pregnant *Idiocerus clypealis* in batches of 2, 5, and 10 were introduced each in the first three cylinders Nos. 1, 3, and 5 of the first series; to the next three cylinders Nos. 2, 4, and 6 the same number of pregnant *I. niveosparsus* were introduced in the same batches of 2, 5, and 10, while the remaining two cylinders Nos. 7 and 8 were not infested, as check. The same procedure was followed in series 2, 3, 4, and 5 when the inflorescences were at the ages of 6, 8, 10, and 15 days, respectively. These five series were duplicated, using a carabao tree instead.

After a month the whole series was examined; the results are given in Table 7.

Table 7 shows interesting results. Series 1: At the age of four days and with a length of 2 to 4 centimeters the inflorescence buds readily succumbed to the infestation by both species of hoppers, all of them having withered before the flowers completed opening.

Series 2: All excepting one, which had but two *Idiocerus clypealis*, were totally damaged.

Series 3: All that had infestation by *Idiocerus niveosparsus* were totally damaged, while those that had but two *I. clypealis* were slightly damaged; those that had five were severely damaged, and those that had ten were completely damaged (Plate 9, figs. 1 and 2).

Series 4: All those infested by *Idiocerus niveosparsus* were totally damaged, except one that had but two, which were severely damaged. Those that had two, five, and ten *I. clypealis* were very slightly, slightly, and severely damaged, respectively.

Series 5: Only those that had ten *Idiocerus niveosparsus* were completely damaged, and those that had five and two were

TABLE 7.—*Time and volume of hopper infestation in relation to extent of damage caused thereby.*[b]

Series.	Cage No.	Inflorescence.		Pregnant hoppers inclosed.	Damage done to the inflorescence by—	
		Age.	Length.		*I. clypealis.*	*I. niveosparsus.*
		Days.	*cm.*			
First	1- 2	4	2- 4	2	Total	Total.
Do.	3- 4	4	2- 4	5	do	Do.
Do.	5- 6	4	2- 4	10	do	Do.
Do.	7- 8	4	2- 4	0	Nil	Nil.
Second	9-10	6	7-10	2	Slight	Total.
Do.	11-12	6	7-10	5	Total	Do.
Do.	13-14	6	7-10	10	do	Do.
Do.	15-16	6	7-10	0	Nil	Nil.
Third	17-18	8	12-16	2	Slight	Total.
Do.	19-20	8	12-16	5	Severe	Do.
Do.	21-22	8	12-16	10	Total	Do.
Do.	23-24	8	12-16	0	Nil	Nil.
Fourth	25-26	10	19-24	2	Negligible	Severe.
Do.	27-28	10	19-24	5	Slight	Total.
Do.	29-30	10	19-24	10	Severe	Do.
Do.	31-32	10	19-24	0	Nil	Nil.
Fifth	33-34	15	31-32	2	do	Slight.
Do.	35-36	15	31-32	5	Negligible	Severe.
Do.	37-38	15	31-32	10	Slight	Total.
Do.	39-40	15	31-32	0	Nil	Nil.

[b] Infestation in first and second series is considered "early." Infestation in third, fourth, and fifth series is considered "late." When there are on the average 1 to 2 hoppers per panicle, the infestation is considered "slight;" 3 to 5 hoppers per panicle, the infestation is considered "moderate;" 6 to 10 hoppers per panicle, the infestation is considered "severe."

severely and slightly damaged, respectively. On the other hand, those that had two, five, and ten *I. clypealis* were not destroyed, very slightly destroyed, and slightly destroyed, respectively. The damage done to this last series by *I. clypealis* was so slight that the panicle had as many fruits as the checks.

In summarizing the results thus obtained one is led to believe that the larger species, *Idiocerus niveosparsus*, is by far the more destructive of the two. This is so, perhaps, not only because it is a faster sucker owing to its larger size, but also probably because the period of its activities with the flower is longer than that of the small species. It is able to lay eggs even on already withering inflorescences and on panicles of young fruits, whereas the small species, *I. clypealis*, can lay eggs only in the fresh flower buds. Past this stage of the development of the flower this species does not seem capable of causing dam-

age to the inflorescences on account of its inability to reproduce thereon as above stated.

It was also made manifest that if the infestation is two or more adults on the average per panicle, the situation should be considered serious.

SPRAYING EXPERIMENT

It might be well to mention here what other investigators have found to be effective treatments for this pest. Ramachandra Rao,(5) in reporting his work on the mango-hopper problem in India, recommended the following remedial measures which he claims to be effective:

1. A preliminary spray of Bordeaux mixture to be given to the inflorescence as the flowers begin to open for preventing the appearance of the mildew; to be repeated once or twice if the mildew be not controlled by the first spray. 2. A thorough spray with fish oil resin soap to be given if hopper is noticed; to be repeated at intervals of a week in case further hatchings are noticeable. It is necessary in this connection to lay special stress on thoroughness of spraying, care being taken to drench the panicles to make sure that all the hoppers are reached, since inefficient spraying is but waste of effort. A spray of lead arsenate may also be given in case caterpillars are found attacking the inflorescences. 3. Lastly, when fruits have set, a supply of irrigation water to be arranged to be given to the trees in case it be feasible. For the dry system of cultivation, a scheme of thorough intercultivation should be adopted, having for its object conservation of soil moisture so as to counteract the heavy fruit-fall.

Palo(4) in his report on mango-blossom spraying experiments in Muntinlupa, Rizal Province, found the following remedial measures effective in increasing the yield of the treated trees many times over the control:

(*a*) A preliminary application of rather strong Bordeaux-lead arsenate given while the inflorescence buds were bursting. (*b*) A second spray of weaker Bordeaux mixture to which nicotine sulphate and lead arsenate were added. (*c*) A third spray of nicotine-soap solution when a new brood of the hopper was noticed, and repeated at intervals of three to six days when further hatchings were observed. (*d*) Another spray of Bordeaux mixture-nicotine sulphate-lead arsenate when the petals were withering.

In the first report above mentioned the presence of mildew and caterpillars in association with the hoppers apparently made the remedial measures somewhat complicated for a layman to follow. In like manner, in the second report the presence of anthracnose and tip-borer in association with the hoppers

made the remedial measures therefor also quite complicated for a grower to follow. By splitting both and eliminating those that are not of immediate necessity for the present purpose, fish-oil-resin soap and nicotine-soap, the backbones of the first and the second treatments, respectively, became manifest and the subject of a more thorough study herein reported.

There was a long spell of dry days when these spraying experiments were conducted, and no trace of anthracnose infection was noted and the tip-borer infestation was not serious. For this reason most of the time during the first lap of the work was devoted to spraying for the hoppers alone and to a search for a more effective and economical spray than the nicotine-soap. These experiments were conducted at four places in Rizal Province; namely, Pasay, Novaliches, Bayanan, and Muntinlupa.

During the early part of this investigation when a general survey of the seriousness of the problem was being made, it was noted (*a*) that there were a very few trees having relatively few hoppers or slight infestation, (*b*) that there were trees having many hoppers or moderate infestation, and (*c*) that there were a few others with abundant hoppers or severe infestation which might occur when the flower heads were only from 1 to 2 centimeters long. For convenience, all the trees that showed slight infestation and those with early severe infestation are discussed on page 247.

NICOTINE-SOAP SPRAY

Nicotine as an insecticide has been the subject of more or less thorough study in the last one hundred years, and has been considered a great factor in the warfare against insect pests. It has been used in the form of tobacco dust, tobacco decoction, or nicotine sulphate solution, the last proving the most effective and economical. Wardle(9) and Buckle suggested that the physiological effect of nicotine upon the insect appears to be one of paralysis of the motor centers, brought about by a condensation of the vapor upon the walls of the tracheæ and subsequent absorption of the liquid by the tissues. This belief seems to have been confirmed by Pickett(10) and others, who reported that nicotine kills by paralyzing the insects after the nicotine vapors have entered the bodies through the breathing pores; that nicotine volatilizes more quickly if the solution has been rendered alkaline, which is easily done by the addition of soap. Palo's(4) report indicated that nicotine-soap helped in

controlling the pest. To verify this and to find out the concentration best suited, the following spraying experiments were conducted using different concentrations of "Black leaf 40" (nicotine sulphate) in a 0.36 per cent soapsud solution, such as given in the following formulas:

Formula 1.	
"Black leaf 40" (nicotine sulphate), cc	120
Chinese yellow laundry soap, g	360
Water, l	100
Formula 2.	
"Black leaf 40" (nicotine sulphate), cc	100
Chinese yellow laundry soap, g	360
Water, l	100
Formula 3.	
"Black leaf 40" (nicotine sulphate), cc	80
Chinese yellow laundry soap, g	360
Water, cc	100

The spray solutions were prepared in the following manner: To make the stock solution, 360 grams of Chinese yellow laundry soap sliced into small pieces, were dissolved in 10 liters of hot (70° to 80° C.) water in a gasoline can. To this stock solution 120 cubic centimeters of "Black leaf 40" were added in a 50-gallon barrel and the resulting solution diluted with enough water to make 100 liters of Formula 1 nicotine-soap spray solution ready for use. The rest of the spray solutions were prepared in like manner but using the corresponding quantities of "Black leaf 40" (nicotine sulphate) indicated in the formulas. Greater or less quantity of the spray solution as needed by the experiments was prepared by either increasing or reducing, proportionally, the amounts of the ingredients given under each formula.

The first spraying test with nicotine-soap of Formula 1 was conducted on two pico trees in Pasay February 13, 1932. The trees were in full bloom with some flowers already opened and showing signs of slight damage due to the severe infestation by *Idiocerus niveosparsus*. This was done to find out what good the spray would do on a tree whose infestation was fairly advanced. Only two trees were treated, because all the others had withered on account of the pest. One-half of the crown of each tree was sprayed, leaving the other half as check. The first spraying was done February 13, 1932, followed by the second, February 17, or four days after, and the third, February 25.

The last had to be applied because of the new brood of nymphs resulting from a reinfestation when the young fruits were already setting. Care was taken to wet thoroughly with the spray solution all the inflorescences and twigs of the treated trees. Cursory examination of the inflorescences after each treatment revealed that the spray was effective as indicated by the great mortality among the young hoppers. In this treatment and in all other subsequent spraying experiments the amount of solution used, as well as the time consumed in the operation, was noted for future reference.

The spraying outfit consisted of Gould's hand spray pump No. 1129 fitted with a 20-meter rubber hose and a Bordeaux nozzle tied to a 5-meter bamboo rod. Two men performed the work; one operated the pump, and the other, holding the bamboo rod with the nozzle, applied the spray to the flowers, leaves, and twigs. The tops of the trees were sprayed with the aid of a 9-meter bamboo ladder provided with props (Plate 10, figs. 1 and 2).

The continuation of the spraying experiments with different strengths of nicotine-soap series was conducted at the hacienda of Dr. N. Jacinto in Novaliches. Five carabao trees were used. They are the outgrowths of the main branches of a carabao tree about a century old that was blown down by a terrific storm years ago. All of them were blooming profusely and showing a more or less even distribution of *Idiocerus clypealis* hopper infestation.

February 16, 1932, one-half of the crown of each of the first two trees was treated with nicotine-soap of Formula 1; one-half of those of the second two trees with nicotine-soap of Formula 2; and one-half of the fifth with nicotine-soap of Formula 3. The remaining five halves were held unsprayed as checks.

Spraying of all the five half-trees was repeated twice to make three applications in all at an interval of three days. Hardly any appreciable difference between the efficacy of the different spray solutions could be noted in as much as in every instance the nymphs died once they got wet with any one of the preparations. It was, nevertheless, noted that more of the less-concentrated solutions had to be used per unit area than the more concentrated to make them as effective. Care was taken in each case to make the application thorough, for it was noted that

the success of the treatment depended much on the thoroughness of application. After the third spraying no additional application was made as there were no new broods of the nymphs coming out.

The next spraying experiment with Formula 2 of nicotine-soap spray was carried out in the Barrio of Bayanan, Muntinlupa. Four carabao and three pico trees in full bloom and with more or less uniform hopper infestation, preponderantly *Idiocerus clypealis*, were used in this experiment, spraying one-half of the crowns February 18, 1932, and repeating two or three times at three or four days interval, depending on the prevalence of the infestation.

Upon maturity during the first week of May, 1932, counts of all the fruits on the trees treated with nicotine-soap including the checks were made. The results are summarized in Table 8.

TABLE 8.—*Results of spraying for blossom-blight hoppers with nicotine-soap solutions containing 0.36 per cent soap and different amounts of "Black leaf 40."*

Variety.	Approximate average area of half crowns with flowers.	Concentration of "Black leaf 40" in the nicotine-soap mixture.	Average amount of spray used.	Average yield of half trees.		Average yield per 100 square meters of crown.	
				Treated.	Check.	Treated.	Check.
	sq. m.	*Per cent.*	*Liters.*	*Fruits.*	*Fruits.*	*Fruits.*	*Fruits.*
Pico [c]	50.5	0.12	135.00	752.0	154.0	1,489.1	304.9
Do	50.5	0.12					
Carabao	50.5	0.12					
Do	50.5	0.12					
Do	74.0	0.10	389.44	1,322.0	293.4	1,786.5	396.5
Do	74.0	0.10					
Do	74.0	0.10					
Pico	74.0	0.10					
Carabao	74.0	0.10					
Do	74.0	0.10					
Pico	74.0	0.10					
Do	74.0	0.10					
Carabao	74.0	0.10					
Do	47.0	0.08	300.00	717.0	135.0	1,525.4	287.2

[c] When the first spray was applied there was already some perceptible damage caused by *Idiocerus niveosparsus* on about 10 to 15 per cent of the inflorescences of the first two pico trees.

SOAPSUD SPRAY

For more than a century soap has held a foremost place in the control of many insect pests. Numerous findings have been written on its insecticidal value, mostly as an emulsifier,

spreader, larvicide, dip, and as contact spray for soft-bodied insects, like plant lice and aphids, some accounts of which have been published by Wardle,(9) Bourcart,(11) and others. In the campaign conducted by the Bureau of Plant Industry of the Philippine Government against the serious outbreak of the coconut leaf-miner (*Promecotheca cumingi* Baly) in almost all the coconut districts of the Archipelago in 1930, Roxas(12) recommended the use of soapsud sprays, preferably with the addition of either nicotine sulphate or arsenate of calcium or lead. The senior author, while working as plant pathologist for the Philippine Packing Corporation in 1930, had the opportunity of investigating and demonstrating the value of soap in the control of the pineapple mealybug (*Pseudococcus brevipes* Ckl.) responsible for the pineapple wilt. Again, it was found in the first series of the spraying experiments with different concentrations of "Black leaf 40" in a soapsud solution of 0.36 per cent, as discussed in the preceding paragraphs, that hardly any difference could be noted by occular observation between the killing power of the spray solutions containing 0.12, 0.1, and 0.08 per cent "Black leaf 40," all having shown 100 per cent efficiency when applied with thoroughness, which seems to indicate the probability of soap as being the main factor in the combination. All this information, pointing to the value of pure soap as an effective insecticide, precipitated a determined action to look into its possibilities as a cheap and effective spray for the control of the mango blossom-blight hoppers.

Relative killing power of the Chinese yellow laundry soap of different strengths.—Soapsud solutions of various concentrations such as 0.1, 0.2, 0.3, 0.4, 0.5, 1, 1.5, 2, and 2.5 per cent were prepared in 3-liter lots, each in a beaker of 4-liter capacity. The test was conducted outdoors under a mango tree with fully developed inflorescences showing the different nymphal stages of *Idiocerus clypealis* and *I. niveosparsus* in great abundance.

Starting from the lowest and ending with the highest concentration in gradual succession, twenty uniform panicles of the inflorescences were submersed in the solution one by one, each lasting about two seconds, taking the time elapsing from the moment they were taken out until the time when all the nymphs succumbed to the effects of the treatment. This procedure was followed throughout until all the tests in the whole series were completed, as given in Table 9. In these tests and in all subsequent tests for the killing power of the solutions, submersion was preferred over spraying in order to have a uniform wetting

of the nymphs which was found very necessary in eliminating as much as possible the source of probable error in the computation of the relative killing power of each solution in terms of the time that elapses between the wetting and the killing of the hoppers. This condition cannot be attained by spraying, owing to the fact that the nymphs are quite evasive, going from side to side of the panicle to avoid the spray, thus the time of killing power obtainable thereof becomes very elastic and unreliable.

TABLE 9.—*Relative killing power of different concentrations of the Chinese yellow laundry soap.*

Strength of solution.	Number of panicles tested.	Average killing power.
Per cent.		*Seconds.*
2.5	20	4
2.0	20	4
1.5	20	5
1.0	20	7
0.5	20	11
0.4	20	16
0.3	20	22
0.2	20	([a])
0.1	20	([b])

[a] Killed first to third stages only. [b] Killed first stage only.

It is shown in Table 9 that the maximum concentration at which 100 per cent kill could be attained in the least possible time was at about 1.5 to 2 per cent, while the minimum concentration at which to attain the same effect but at a longer duration was at about 0.3 per cent. These results seem to indicate that the right concentration of soap solution for mango blossom-blight hopper control lies midway between 0.4 and 0.5 per cent, beyond which the solution would either be too weak to be effective and economical, or too strong to be feasible.

Comparative efficacy of the different kinds of soap.—A solution of 0.5 per cent concentration of each of various kinds of soap was prepared, and each was tested for its killing power as a control for the mango blossom-blight hoppers. The same procedure of testing as in the preceding experiment was followed throughout the entire series. The results are given in Table 10, in descending order from the most effective to the least effective.

TABLE 10.—*Comparative efficacy of various kinds of soap used for the control of blossom-blight hoppers.*

Kind of soap.	Strength.	Panicles tested.	Average killing power.
	Per cent.		*Seconds.*
Chinese yellow	0.5	20	11
Señorita	0.5	20	12
Palmolive	0.5	20	12
Resin soap	0.5	20	15
Ivory	0.5	20	16
Chinese white	0.5	20	17
Lenox	0.5	20	17
Sanitary	0.5	20	22
Chinese raw	0.5	20	Nil.

From the standpoints of efficacy and cheapness of material, it is shown in the tabulation above that the Chinese yellow laundry soap leads, closely followed by Señorita and resin soaps. This Chinese yellow laundry soap is a local product from coconut oil.

The effect of heat on the killing power of soapsud.—When soapsud solutions ranging from 0.1 to 0.5 per cent were heated at from 40° to 45° C. and a comparative test of their killing power was conducted in the same way as in the unheated series, the results shown in Table 11 were obtained.

TABLE 11.—*Effect of heat on the killing power of soapsud for the control of blossom-blight hoppers.*

Strength of soap solution.	Panicles tested.	Average killing power.	
		Cold solution (28°–29° C.).	Hot solution (40°–45° C.).
0.1	20	Killed 1st stage only	Killed 1st and 2d stages only.
0.2	20	Killed 1st to 3d stages only	Killed in 9 seconds.
0.3	20	Killed in 22 seconds	Killed in 5 seconds.
0.4	20	Killed in 16 seconds	Instantaneous.
0.5	20	Killed in 11 seconds	Do.

Heating the solution to a temperature ranging from 40° to 45° C. (which is not too hot for the hand to withstand in submersion for a minute or so) greatly increased the killing power of the soap solutions, so much so that a 0.2 per cent solution accomplished 100 per cent kill two seconds quicker than a 0.5

per cent cold solution did. In view of the cheapness of soap the practicability of heating the solution is dubious, however.

The effect of "sticker" on the killing power of soapsud.—Three sets of a 0.4 per cent soapsud solution of 3 liters each were prepared. Then 7.5 grams of fine pottery clay were added to the first set and a good emulsion was made by thoroughly stirring the solution. The second solution was prepared by adding 3 cubic centimeters of resin-sal-soda sticker (made by dissolving 1 part of resin in 1 part of sodium hydroxide, diluting it with enough water to make 1 liter of the solution) to the soapsud solution. The third solution was kept without the sticker as check. The same procedure of testing for the killing power as discussed in the preceding paragraphs was followed in this experiment. The results are noted in Table 12.

TABLE 12.—*Effect of "sticker" on the killing power of soapsud solution.*

Solution.	Panicles tested.	"Sticker" added.	Average killing power.
			Seconds.
Soapsud, 0.4 per cent	20	Clay, 0.25 per cent	12
Do	20	Resin, 0.1 per cent	12
Do	20	None	16

It may be seen from Table 12 that the addition of either sticker increased the killing power of the soapsud solution, but the increase does not seem to be sufficient to warrant its use in practice.

FIELD APPLICATIONS

The results of the preceding experiments tend to show that soapsud as a spray for mango blossom-blight hoppers, even without the addition of any other insecticide, is very promising. To determine its practical usefulness in combating this pest the following spraying experiments were carried out in Bayanan, Muntinlupa, beginning February 18, 1932. The experiments were laid out as follows:

Three carabao and eleven pico trees in full bloom and showing a more or less uniform distribution of leaf-hoppers, mostly *Idiocerus clypealis*, were sprayed with a 0.5 per cent soapsud solution on one-half of the crowns, leaving the other halves unsprayed as checks. Spraying was repeated two or three times at two to five days' intervals, depending on the prevalence of the young hoppers. The results are given in Table 13.

TABLE 13.—*Results of spraying for blossom-blight hoppers, Idiocerus clypealis and I. niveosparsus, with 0.5 per cent soapsud solution.*

Variety.	Approximate area of half crown.	Amount of spray used.	Yield on half trees.		Average yield per 100 square meters of crown.	
			Treated.	Check.	Treated.	Check.
	sq. m.	*l.*	*Fruits.*	*Fruits.*	*Fruits.*	*Fruits.*
Carabao	49.0	260	657	224	1.341	457
Do	24.0	220	312	83	1,300	346
Do	60.0	400	1,153	192	1,922	320
Pico	53.0	260	413	144	779	272
Do	68.0	560	879	256	1,293	376
Do	59.0	240	722	128	1,224	217
Do	55.0	560	592	96	1,076	175
Do	67.5	440	802	223	1,188	330
Do	79.0	640	1,174	329	1,486	416
Do	20.0	180	189	48	945	240
Do	32.0	240	210	45	656	141
Do	26.0	220	220	33	846	127
Do	36.0	110	295	49	819	136
Do	44.0	160	456	92	1,036	209
Average	48.0	320.7	576.7	138.5	1,136.5	268.7

This was immediately followed by another series in which 0.4 per cent soapsud solution was used to spray seventeen carabao and nine pico trees at the hacienda of Mr. Vicente Madrigal in Muntinlupa. These trees differed from those of the first series in the profuseness of the flowers, ranging from few to abundant, resulting perhaps from late flowering. The hopper infestation ranged from slight to severe, but generally from moderate to severe, with *Idiocerus clypealis* predominating. Beginning March 17, 1932, the half crowns of the trees showing from first to third stages of the hopper nymphs were sprayed, leaving the other halves untreated as checks. This was repeated three to six times at two- or three-day intervals, depending on the prevalence of the nymphs. The results are given in Table 14.

In every instance the treatment showed 100 per cent kill on the hopper nymphs that got wet with the spray solution as has been the case generally whenever thorough application was made. Like the nicotine-soap, soapsud solution, particularly 0.5 per cent, was so effective that even the adult hoppers perished when they got completely drenched. It was found, however, that no matter how thorough the application a few of the insects managed to avoid the spray. The adults escaped by flight, as soon as they heard the noise produced by the spraying.

TABLE 14.—*Results of spraying for blossom-blight hoppers with 0.4 per cent soapsud solution.*

Variety.	Approximate area of half crown.	Amount of spray used.	Yield on half trees.		Average yield per 100 square meters of crown.	
			Treated.	Check.	Treated.	Check.
	sq. m.	*l.*	*Fruits.*	*Fruits.*	*Fruits.*	*Fruits.*
Carabao	39.0	540	260	78	666	200
Do	88.0	1,240	1,008	338	1,145	384
Do	75.0	820	519	187	692	249
Do	113.0	820	432	93	382	82
Do	43.0	420	193	0	449	0
Do	88.0	740	397	132	451	150
Do	73.5	930	775	105	1,054	143
Do	53.0	690	714	231	1,347	436
Do	27.0	370	227	59	841	219
Do	66.5	960	620	157	932	236
Do	37.5	920	412	45	1,099	120
Do	27.0	480	196	23	726	85
Do	52.0	610	603	44	1,160	85
Do	82.5	910	487	34	590	41
Do	52.5	700	405	107	771	204
Do	25.0	290	108	38	432	152
Do	48.0	860	368	10	767	21
Pico	94.0	890	1,326	257	1,411	273
Do	98.0	1,400	925	134	944	137
Do	87.0	1,120	684	78	786	90
Do	83.5	960	486	164	582	196
Do	81.5	860	441	58	541	71
Do	94.0	1,330	853	184	907	196
Do	60.5	1,020	1,148	166	1,898	274
Do	28.5	340	185	27	649	95
Do	39.0	420	269	62	690	159
Average	63.7	793.85	540	108.1	838.9	165.3

SOAPSUD VS. NICOTINE-SOAP

In view of the fact that soapsud when used alone, even at the strength of 0.3 per cent, could cause 100 per cent kill on the nymphs of the mango-blight hoppers and, owing to the rather insignificant difference in the killing power between the nicotine-soap sprays of formulas 1, 2, and 3 containing 0.12, 0.1, and 0.08 per cent of "Black leaf 40," respectively, in a 0.36 per cent soapsud solution as pointed out under nicotine-soap spray, it was suspected that soap was the main active principle in the combinations. It was felt necessary, therefore, to lay out some more experiments under more or less controlled conditions whereby the relative value of soap and "Black leaf 40" taken individually and in combination, to attain the best possible

results, could be determined. The following experiments were conducted to clarify this point:

Seven and one-half liters of 0.5 per cent soapsud solution and an equal amount and strength of "Black leaf 40" solution were prepared in two separate containers. Five beakers of 4-liter capacity were numbered from 1 to 5, respectively; then into each of the containers the solutions were poured in single and combined forms, in the following order: Beaker 1, 3 liters of soapsud; beaker 2, 3 liters of "Black leaf 40;" beaker 3, 1.5 liters of soapsud and 1.5 liters of "Black leaf 40;" beaker 4, 2 liters of soapsud and 1 liter of "Black leaf 40;" and beaker 5, 1 liter of soapsud and 2 liters of "Black leaf 40."

Following exactly the same procedure as that given under soapsud spray, the relative killing power of each solution thus prepared was tested. The results are given in Table 15.

TABLE 15.—*Relative killing power of 0.5 per cent soapsud solution and 0.5 per cent "Black leaf 40" solution when used singly and in combination.*

Beaker No.	Solution.	Proportion of the combination.	Strength.		Killing power.
			Soapsud.	Nicotine-soap.	
			Per cent.	*Per cent.*	*Seconds.*
1	Soapsud alone		0.5		11
2	"Black leaf 40" alone			0.5	660
3	Soapsud plus "Black leaf 40"	1:1	0.25	0.25	16
4	Do	2:1	0.33	0.17	12
5	Do	1:2	0.17	0.33	26

It may be seen from Table 15 that soap seems to be the main factor in the nicotine-soap combination spray; that 0.5 per cent soapsud could kill all the nymphal stages of the mango blossom-blight hoppers in eleven seconds when the infested panicle was submerged in the solution for about two seconds; and "Black leaf 40" of the same strength could not kill by the same treatment in less than eleven minutes. This discrepancy in their killing power may be explained by the fact that the toxicity or efficacy of nicotine sulphate or "Black leaf 40" as a contact insecticide depends on the availability of its nicotine content, which Pickett(10) and others believe to be dependent in turn, at least in part, on the alkalinity produced in the solution by the addition of soap or other alkalies. The same table further shows that a combination of the two in any one of the proportions tried,

as 1 to 1, 2 to 1, and 1 to 2 did not give as good results as soapsud of the same strength taken alone. There was an indication, however, that better results could be attained by using more soap in the combination. To follow this up the following experiments were carried out:

Fifteen liters of 0.5 per cent soapsud solution were prepared; equal amounts were placed in five 4-liter beakers, which were numbered from 1 to 5, respectively. Leaving out the first which was held as check, undiluted "Black leaf 40" was added to each of the four solutions in amounts of 0.75, 1.5, 2.5, and 3 cubic centimeters, respectively, and the resulting solution was stirred for some time. The efficacy of each solution thus prepared was then tested in the same way as in the preceding tests.

At the completion of the test it was deemed necessary to run two more of the same series, but with 0.4 and 0.3 per cent instead of 0.5 per cent as the stock soapsud solutions. The results of the three series are given in Table 16.

TABLE 16.—*Comparative efficacy of soapsud and nicotine-soap solutions of various concentrations for blossom-blight hoppers.*

Series.	Panicles used.	Solution (3 liters each).	Strength.		Killing power.
			Soapsud.	Nicotine-soap.	
			Per cent.	*Per cent.*	*Seconds.*
First	20	Soapsud alone	0.5		11
Do	20	Soapsud plus "Black leaf 40"	0.5	0.025	9
Do	20	do	0.5	0.05	8
Do	20	do	0.5	0.075	8
Do	20	do	0.5	0.1	8
Second	20	Soapsud alone	0.4		17
Do	20	Soapsud plus "Black leaf 40"	0.4	0.025	16
Do	20	do	0.4	0.05	14
Do	20	do	0.4	0.075	15
Do	20	do	0.4	0.1	13
Third	20	Soapsud alone	0.3		22
Do	20	Soapsud plus "Black leaf 40"	0.3	0.025	19
Do	20	do	0.3	0.05	17
Do	20	do	0.3	0.075	18
Do	20	do	0.3	0.1	18

From Table 16 it may be seen that nicotine-soap solutions of various concentrations proved to be more effective than soapsud alone. The combinations that gave the best results are those containing from 0.05 to 0.1 per cent "Black leaf 40," the average killing power being 13 seconds for 0.05 per cent, 13.6 seconds

for 0.075 per cent, and 13 seconds for 0.1 per cent. It appears that the average killing power of 0.05, 0.075, and 0.1 per cent nicotine-soap solutions is practically the same, which would seem to convey the idea that the excess of "Black leaf 40" over 0.05 per cent does not give any additional benefit; if so, it might be due to the nonliberation of nicotine in the excess "Black leaf 40." While this explanation seems tenable, it remains doubtful, nevertheless, whether the same effect could be obtained if the solutions were applied in the form of spray.

There seems to be no doubt, however, that soap is the main active principle in the combination. It may not be amiss to mention the particular properties or constituents of soap responsible for killing the insects that are treated. Various opinions have been expressed on this question, among which mechanical obstruction of the body openings and the caustic properties of the alkaline constituents have apparently received the support of many researchers. Siegler(13) and Popenoe discredited these beliefs and advanced the theory based on their findings that it is the release of the acid components through hydrolytic dissociation that causes the toxicity of soaps when used as contact sprays. They say:

> If the mechanical obstruction of the body openings or the action of the free alkali is responsible for the toxicity of soap, an increase of toxicity should be obtained by every increase in concentration. On the other hand, if the free fatty acids are the toxic agents, and these are dependent for their action upon absorption through the insect membranes, the familiar characteristics of insecticidal soap solutions might be expected to assert themselves.

In conformity with this theory the senior author found (as shown in Table 9) that by increasing the concentration of Chinese yellow laundry soap beyond 2 per cent no corresponding increase in toxicity to the blossom-blight hoppers was obtained; that 0.5 per cent sodium hydroxide solution when tested for killing power proved to be devoid of toxicity even to the youngest nymphs; and that a solution of 0.5 per cent lactic acid in pure form was as nontoxic as the alkali, while a fermented milk which contains probably not as much lactic acid proved toxic. The last point would seem to suggest that the decomposition products of the fat content of milk are responsible for the toxic effect shown. The theory that the fatty acid content of soap is the active principle in soapsud when used as a contact insecticide, is thus supported.

How the fatty acids kill the insects is not well understood. Siegler(13) and Popenoe advanced the hypothesis that the fatty acids in a crystalloid state penetrate the insect's body walls and tracheæ, thus gaining immediate hæmolytic action on the hæmolymph and body cells. On the other hand, Shafer(14) found that heat of certain intensities and the several contact insecticides he studied (gasoline, carbon disulphide, hydrocyanic acid gas, sodium fluoride, etc.), when used at a concentration sufficient to kill insects, deleteriously affected the activities of reductases, catalases, and oxidases, usually in unequal degree, thus disturbing the natural or normal balance of such activities. These activities being of vital importance to the life processes of the tissue cells, the above-stated deleterious action must be an important factor in causing the death of the treated insects. This hypothesis goes far in explaining why soapsud solutions of various concentrations, when heated at from 40° to 45° C. (Table 11), increase their toxicity to the blossom-blight hoppers much more than when they are applied at room temperature.

In view of the results obtained in the foregoing experiments, the question as to which of the two spray solutions (soapsud or nicotine-soap) is the better for the purpose, is raised. Spraying experiments were then laid out by using; first, 0.5 per cent soapsud vs. nicotine-soap, Formula 2, containing 100 cubic centimeters "Black leaf 40," 360 grams Chinese yellow laundry soap and 100 liters water; second, 0.4 per cent soapsud vs. nicotine soap, Formula 2; and third, 0.4 per cent soapsud vs. nicotine-soap, Formula 4, containing 50 cubic centimeters "Black leaf 40," 300 grams Chinese yellow laundry soap, and 100 liters water.

The first set was conducted at Bayanan, Muntinlupa, beginning February 20, 1932. Half crowns of two carabao and two pico trees showing profuse inflorescences and a moderate to severe hopper infestation, mostly by *Idiocerus clypealis*, were sprayed with 0.5 per cent soapsud solution, while the other halves were sprayed with nicotine-soap solution, Formula 2, repeated four times at three-day intervals. For checks, four adjacent trees having practically the same crown area, profuseness of flowers, and hopper infestation were left unsprayed. The results are given in Table 17.

For lack of available trees in Bayanan the second set was immediately laid out after this at the hacienda of Mr. Vicente

Madrigal in Muntinlupa. In this set 0.4 per cent soapsud solution was tried vs. nicotine-soap, Formula 2, on three carabao and four pico trees with severe hopper infestation by both species, spraying half crowns with the former and the other half crowns with the latter. Four or five applications were given to each side at two- or three-day intervals, depending on the prevalence of the infestation. Check trees of the same number having practically the same crown area, profuseness of flower, and distribution of severe hopper infestation were chosen from the same lot. The results are given in Table 18.

TABLE 17.—*Results of spraying for blossom-blight hoppers with 0.5 per cent soapsud solution vs. nicotine-soap solution containing 0.36 per cent soap and 0.1 per cent "Black leaf 40."*

Variety.	Approximate area of half crown.	Amount of spray used.		Yield on half trees.		
		Soap.	Nicotine-soap.	Soap.	Nicotine-soap.	Check.
	sq. m.	*l.*	*l.*	*Fruits.*	*Fruits.*	*Fruits.*
Carabao	52.0	340	260	816	785	
Do	57.0	470	360	888	882	
Pico	73.0	460	360	1,230	1,420	
Do	44.0	330	280	570	710	
Average	56.5	400	315	876	949.2	138.7
Average yield per 100 square meters of crown				1,550.4	1,680.0	289.2

TABLE 18.—*Results of spraying for blossom-blight hoppers with 0.4 per cent soapsud solution vs. nicotine-soap solution containing 0.36 per cent soap and 0.1 per cent "Black leaf 40."*

Variety.	Approximate area of half crown.	Amount of spray used.		Yield on half trees.		
		Soap.	Nicotine-soap.	Soap.	Nicotine-soap.	Check.
	sq. m.	*l.*	*l.*	*Fruits.*	*Fruits.*	*Fruits.*
Carabao	97.0	720	400	612	709	
Do	56.0	800	620	823	1,024	
Do	113.0	1,450	750	1,352	1,701	
Pico	36.0	520	280	389	507	
Do	49.0	560	250	656	908	
Do	110.0	900	680	1,875	2,535	
Do	47.0	700	420	462	857	
Average	72.5	807.14	485.7	881.3	1,177.3	108.1
Average yield per 100 square meters of crown				1,215.6	1,623.9	170.2

The third set, which consisted of 0.4 per cent soapsud vs. nicotine-soap, Formula 4, was laid out on five carabao trees also at the hacienda of Mr. Vicente Madrigal, May 5, 1932. The trees had moderate amounts of flowers, and more or less the same crown area, with moderate hopper infestation, preponderantly of *Idiocerus clypealis*. The crown of each tree was divided into three equal parts; one part was treated with 0.4 per cent soapsud, another part with nicotine-soap, Formula 4, and the middle part was left unsprayed as check. Four applications were made on both sides at two- or three-day intervals, depending on the infestation. The results are given in Table 19.

TABLE 19.—*Results of spraying for blossom-blight hoppers with 0.4 per cent soapsud solution vs. nicotine-soap solution containing 0.3 per cent soap and 0.05 per cent "Black leaf 40."*

Variety.	Approximate area of half crown.	Amount of spray used.		Yield on half trees.		
		Soap.	Nicotine-soap.	Soap.	Nicotine-soap.	Check.
	sq. m.	*l.*	*l.*	*Fruits.*	*Fruits.*	*Fruits.*
Carabao	71.0	400	320	1,543	1,592	472
Do	64.0	380	360	727	696	133
Do	46.0	270	210	296	267	49
Do	56.0	420	380	343	241	30
Do	40.5	300	290	384	386	108
Average	55.5	354	312	658.6	636.4	158.4
Average yield per 100 square meters of crown				1,186.7	1,146.7	285.4

It was noted in the first two cases in the three foregoing spraying experiments that nicotine-soap was more effective than soapsud of the concentrations tried for the control of the blossom-blight hoppers. This was indicated first, by the greater rapidity with which it kills the hoppers and, second, by the smaller amount of solution consumed per unit area of the crown treated. It was similarly observed that both soapsud and nicotine-soap of higher concentrations were more efficient killers than the same solutions of less concentrations. This would seem to show that in the case of nicotine-soap solution the results obtained from immersion tests (Table 16) are not indicative of the true efficiency of the spray, that nicotine-soap is more effective as a spray than as a dip, and that the proper evaluation of the efficacy of nicotine-soap as a contact insecticide can only be made through actual spraying.

Whether or not these observations concur with the results attained in terms of pesos and centavos net profit [5] realized from each treatment is shown by Table 20, which summarizes all the preceding spraying experiments.

The net gain obtainable from each treatment is variable, of course, depending on various factors, among which are the market price of the crop so produced which oscillates between 2 and 15 pesos per kaing, cost of spray materials, cost of labor, and success of the spraying; the last, in turn, depends on several factors, principal among which are the right time and thoroughness of the application.

SPRAYING TREES WITH SLIGHT INFESTATION OCCURRING LATE AND TREES WITH SEVERE INFESTATION OCCURRING EARLY

During the early part of this investigation when the seriousness of the problem was being surveyed, it was noted that some trees had but relatively few hoppers or slight infestation, others had many hoppers or moderate infestation, and still a few others had abundant hoppers or severe infestation that might have occurred as early as when the flower heads were only from 1 to 2 centimeters long. As previously mentioned in the early part of the spraying experiments, all of the sprayed trees that fall under the first and third classifications were set aside for this later discussion.

[5] The computation for net profit obtained from all the spraying experiments was based on the following figures:

Cost of spray materials.—Chinese yellow laundry soap, 1 kilo, 0.20 peso; "Black leaf 40," 1 cubic centimeter (0.5-pound bottle of 190 cubic centimeters at 2.52 pesos), 0.133 peso.

Cost of labor for spraying.—Two laborers working together with a hand spray pump could discharge on the average about 89 liters of the spray in an hour, or about 800 liters in a day. The laborers were paid 0.80 peso each a day. At this rate it cost 0.002 peso to discharge 1 liter of the spray.

Cost of labor for picking.—A laborer working at 0.80 peso a day can pick on the average 1,250 fruits (or 10 kaings of the carabao variety) It costs to pick one fruit 0.00064 peso.

Value of mangos per kaing (variable).—Carabao: One kaing of 125 fruits at 3 pesos or 0.024 peso a fruit. Pico: One kaing of 175 fruits at 2.50 pesos or 0.0143 peso a fruit.

TABLE 20.—*Comparative expenses incurred in, and yield and profit obtained by, spraying mango trees of two varieties with soapsud and nicotine-soap to control blossom-blight hoppers.*

CARABAO VARIETY.

Series.	Treatment.	Trees treated.	Average area of crown.	Average yield per half tree.			Average value of the crop.			Average expenses (material and labor).		
				Soapsud.	Nicotine-soap.	Check.	Soapsud.	Nicotine-soap.	Check.	Soapsud.	Nicotine-soap.	Check.
			sq. m.	*Fruits.*	*Fruits.*	*Fruits.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*
1	Nicotine soap, 0.36 per cent soap +0.12 per cent "Black leaf 40" vs. checks	2	133	----------	1,329.0	308.0	----------	31.896	7.392	----------	3.652	0.197
2	Nicotine soap, 0.36 per cent soap+0.1 per cent "Black leaf 40" vs. checks	6	153	----------	1,437.8	329.8	----------	34.488	7.915	----------	7.073	0.211
3	Nicotine soap, 0.36 per cent soap +0.08 per cent "Black leaf 40" vs. checks	1	94	----------	717.0	135.0	----------	17.208	3.240	----------	4.466	0.086
4	Soap, 0.5 per cent vs. checks	3	88	707.3	----------	166.3	16.968	----------	3.991	1.331	----------	0.106
5	Soap, 0.4 per cent vs. checks	17	116	454.3	----------	98.8	10.903	----------	2.371	2.315	----------	0.063
6	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. soap, 0.5 per cent	2	110	852.0	833.5	207.9	30.443	20.004	4.989	1.760	5.499	0.133
7	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. soap, 0.4 per cent	3	177	929.0	1,144.6	150.8	22.296	27.470	3.619	3.364	10.203	0.097
8	Nicotine soap, 0.3 per cent soap +0.05 per cent "Black leaf 40" vs. soap, 0.4 per cent	5	111	658.6	636.4	158.4	15.806	15.273	3.801	1.412	3.292	0.101

Series.	Treatment.	Trees treated.	Average area of crown.	Average net returns.			Average net profit per half tree.		Average net profit per tree.		Average net profit per 100 square meters of crown.	
				Soapsud.	Nicotine-soap.	Check.	Soapsud.	Nicotine-soap.	Soapsud.	Nicotine-soap.	Soapsud.	Nicotine-soap.
			sq. m.	Pesos.	Pesos.	Pesos.	Pesos.	Pesos.	Pesos.	Pesos.	Pesos.	Pesos.
1	Nicotine soap, 0.36 per cent soap +0.12 per cent "Black leaf 40" vs. checks	2	133	....	28.244	7.195	....	21.05	....	42.10	....	31.65
2	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. checks	6	153	....	27.415	7.704	....	19.71	....	39.42	....	25.76
3	Nicotine soap, 0.36 per cent soap +0.08 per cent "Black leaf 40" vs. checks	1	94	....	12.742	3.154	....	9.59	....	19.18	....	20.40
4	Soap, 0.5 per cent vs. checks	3	88	15.637	....	3.885	11.75	....	23.50	....	26.70	....
5	Soap, 0.4 per cent vs. checks	17	116	8.588	....	2.308	6.28	....	12.56	....	10.83	....
6	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. soap, 0.5 per cent	2	110	18.688	14.505	4.856	13.83	9.65	27.66	19.30	25.14	17.55
7	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. soap, 0.4 per cent	3	177	18.932	17.269	3.522	15.41	13.75	30.82	27.50	17.41	15.54
8	Nicotine soap, 0.3 per cent soap +0.05 per cent "Black leaf 40" vs. soap, 0.4 per cent	5	111	14.394	11.981	3.700	10.69	8.28	21.38	16.56	19.26	14.92
	Average gain for all treatments per 100 square meters of crown										19.87	20.97
	Average gain for the last three treatments per 100 square meters of crown										20.60	16.00

TABLE 20.—*Comparative expenses incurred in, and yield and profit obtained by, spraying mango trees of two varieties with soapsud and nicotine-soap to control blossom-blight hoppers*—Continued.

PICO VARIETY.

Series.	Treatment.	Trees treated.	Average area of crown.	Average yield per half tree.			Average value of the crop.			Average expenses (material and labor).		
				Soapsud.	Nicotine-soap.	Check.	Soapsud.	Nicotine-soap.	Check.	Soapsud.	Nicotine-soap.	Check.
			sq. m.	*Fruits.*	*Fruits.*	*Fruits.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*
1	Nicotine soap, 0.36 per cent soap +0.12 per cent "Black leaf 40" vs. checks	2	69	---------	175.0	0	---------	2.502	0	---------	2.353	0
2	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. checks	3	140	---------	1,090.3	220.6	---------	15.587	3.154	---------	7.109	0.141
4	Soap, 0.5 per cent vs. checks	11	98	541.1	---------	131.2	7.737	---------	1.876	1.330	---------	0.083
5	Soap, 0.4 per cent vs. checks	9	148	701.8	---------	125.5	10.035	---------	1.794	3.043	---------	0.080
6	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. soap, 0.5 per cent	2	117	900.0	1,065.0	227.8	12.870	15.229	3.257	1.761	5.807	0.146
7	Nicotine soap, 0.36 per cent +0.1 per cent "Black leaf 40" vs. soap, 0.4 per cent	4	120	845.5	1,201.7	101.8	12.090	17.184	1.455	2.417	7.290	0.065

Series.	Treatment.	Trees treated.	Average area of crown.	Average net returns.			Average net profit per half tree.		Average net profit per tree.		Average net profit per 100 square meters of crown.	
				Soapsud.	Nicotine-soap.	Check.	Soapsud.	Nicotine-soap.	Soapsud.	Nicotine-soap.	Soapsud.	Nicotine-soap.
			sq. m.	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*
1	Nicotine soap, 0.36 per cent soap +0.12 per cent "Black leaf 40" vs. checks	2	69	----------	0.149	0	----------	0.15	----------	0.30	----------	0.43
2	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. checks	3	140	----------	8.478	3.013	----------	5.47	----------	10.94	----------	7.81
4	Soap, 0.5 per cent vs. checks	11	98	6.407	----------	1.793	4.61	----------	9.22	----------	9.41	----------
5	Soap, 0.4 per cent vs. checks	9	148	6.992	----------	1.714	5.28	----------	10.56	----------	7.14	----------
6	Nicotine soap, 0.36 per cent soap +0.1 per cent "Black leaf 40" vs. soap, 0.5 per cent	2	117	11.109	9.422	3.111	8.00	6.31	16.00	12.62	13.68	10.79
7	Nicotine soap, 0.36 per cent +0.1 per cent "Black leaf 40" vs. soap, 0.4 per cent	4	120	9.673	9.894	1.390	8.28	8.50	16.56	17.00	13.80	14.17
	Average gain for all treatments per 100 square meters of crown										11.01	8.30
	Average gain for the last two treatments per 100 square meters of crown										13.74	12.48

Included in this test are two carabao trees with slight infestation, and one carabao and six pico trees with severe infestation. Half crowns of the trees were sprayed with 0.5 per cent soapsud solution four to five times at three-day intervals, leaving the other halves untreated as check. The results are given in Table 21.

DISCUSSION OF RESULTS

NICOTINE-SOAP SPRAY

It is shown in Table 8, first, that nicotine-soap spray, Formula 1, containing 0.36 per cent soap and 0.12 per cent "Black leaf 40" (nicotine sulphate), when used to control the blossom-blight pest of mango increased on the average the yield of the treated trees 4.9 times that of the check or the untreated (Plate 11, figs. 1 and 2); second, that when the amount of "Black leaf 40" in the same combination was reduced to 0.1 per cent, Formula 2, the yield of the treated trees was increased 4.5 times that of the check; and, third, that when the amount of "Black leaf 40" was further reduced to 0.08 per cent, Formula 3, the yield of the treated trees was increased 5.3 times that of the check. It would appear offhand from these results that there was not much difference between the treatments. If there be any at all, it is in favor of Formula 3 that has the least amount of nicotine in the solution. This difference in the yield of fruits, however, conceals the true efficiency of each treatment. By splitting the two varieties apart and computing the total expenses incurred (including the labor and the spray materials used) in producing the corresponding yields per 100 square meters of crown, the net profit realized from each treatment on the carabao variety as shown in Table 20, series 1 to 3, is 31.65, 25.76, and 20.40 pesos for the first, second, and third treatments, respectively.

It is interesting to note that the gradual increase in the net profit coincides with the gradual increase in the concentration of the corresponding spray solutions used. In other words, the net profit obtained by spraying carabao variety with nicotine-soap is directly proportional to the increase in the concentration of the spray solution used. It would seem from this that greater profit may be realized by spraying carabao mangos with nicotine-soap solution, Formula 1, containing not less than 0.12 per cent of "Black leaf 40" than by using less-concentrated solutions. This may be explained perhaps by the fact that, in order to attain the same killing effect, a greater amount of the

TABLE 21.—*Results of spraying with 0.5 per cent soapsud solution trees with slight infestation and trees with severe, early infestation by blossom-blight hoppers.*

Tree No.	Variety.	Approximate area of half crown.	Sprayings.	Amount of spray used.	Yield on half trees.		Value of the crop.	
					Treated.	Check.	Treated.	Check.
		sq. m.		*l.*	*Fruits.*	*Fruits.*	*Pesos.*	*Pesos.*
24	Carabao	60.5	3	260	1,313	784	31.51	18.82
44	do	90.5	5	860	2,077	1,996	49.85	47.90
6	do	49.0	5	470	646	412	15.50	9.82
12	Pico	72.5	5	610	1,098	1,078	15.70	15.42
45	do	112.0	3	500	1,897	1,063	26.93	15.20
60	do	47.0	6	500	186	19	2.66	0.271
61	do	36.0	6	450	196	32	2.80	0.457
64	do	76.5	6	800	273	4	3.90	0.057
65	do	49.0	6	560	185	8	2.65	0.114

Tree No.	Variety.	Expenses.		Net returns.		Net profit per tree.	Net profit per 100 square meters of crown.	Time and volume of infestation.
		Treated.	Check.	Treated.	Check.			
		Pesos.	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	*Pesos.*	
24	Carabao	1.62	0.50	29.89	18.32	+11.57	+19.12	Slight-late.
44	do	3.91	1.28	45.94	46.62	— 0.68	— 0.75	Do.
6	do	1.82	0.26	13.68	9.63	+ 4.05	+ 8.26	Severe-early.
12	Pico	2.53	0.69	13.17	14.73	— 1.56	— 2.15	Do.
45	do	2.71	0.68	24.22	14.52	+ 9.70	+ 8.66	Do.
60	do	1.62	0.012	1.04	0.26	+ 0.78	+ 1.66	Do.
61	do	1.48	0.020	1.32	0.44	+ 0.88	+ 2.44	Do.
64	do	2.57	0.002	1.33	0.06	+ 1.27	+ 1.66	Do.
65	do	1.80	0.005	0.85	0.11	+ 0.74	+ 1.51	Do.

less-concentrated solution had to be used per unit area of crown than the more-concentrated solution, thereby incurring correspondingly greater labor expense, which in this case happened to be the deciding factor in determining the margin of profit and loss, all of the treatments being equally effective at practically the same cost although of different volumes of materials.

It may be seen from Table 20, which gives the results from the same treatments on the pico variety, on the other hand, that the reverse is true; namely, that the greater the amount of "Black leaf 40" in the spray solution used, the smaller the profit obtained. This seems to indicate that the pico variety is more susceptible to the toxic effect of the nicotine-soap solution than the carabao variety. In spraying the pico variety for the blossom-blight hoppers the less-concentrated solution of nicotine-soap should therefore be preferred to attain good results.

SOAPSUD SPRAY

It may be seen from Table 13 that spraying mango trees of both carabao and pico varieties with 0.5 per cent soapsud solution for the control of blossom-blight hoppers, increased on the average the yield of the treated side 4.2 times that of the check or the untreated (Plate 12, figs. 1 and 2), while the treatment with a weaker·concentration (0.4 per cent) of the same spray solution yielded seemingly better results, increasing the crop of the treated sides five times that of the unsprayed or the checks (Plate 13, figs. 1 and 2) as shown in Table 14. Analysis of the data shows that this is not the case. Splitting the two varieties apart and computing the total expenses incurred in spraying each carabao tree of 100 square meters crown, the net profit obtained is 26.70 pesos for 0.5 per cent solution as against 10.83 pesos for 0.4 per cent solution (Table 20, series 4 and 5).

These results indicate that spraying for blossom-blight hopper control on carabao mango with 0.5 per cent soapsud would give better returns than spraying with 0.4 per cent soapsud. It may be seen from Table 20, series 4 and 5, which gives the results from the same treatments on the pico variety, that, as in the case of nicotine-soap spray and perhaps for the same reason that pico has a more-delicate inflorescence, the less-concentrated spray solution (0.4 per cent) gave on the average a larger net profit than the more concentrated (0.5 per cent).

SOAPSUD VS. NICOTINE-SOAP

When 0.5 per cent soapsud was tested against Formula 2 of nicotine-soap containing 0.36 per cent soap and 0.1 per cent "Black leaf 40" side by side on the same trees to control the blossom-blight pest, the treatments yielded on the average per 100 square meters of crown 1,550.4 fruits for the former and 1,680 fruits for the latter as against 289.2 fruits for the checks or the untreated (Table 17). It appears, therefore, that while soapsud increased the yield of the treated sides per 100 square meters of crown 5.4 times that of the check, nicotine-soap increased it 5.8 times, indicating that nicotine-soap spray is slightly more effective than soapsud spray at the concentrations above given for the control of blossom-blight hoppers (Plate 14, figs. 1 and 2).

Again, it is shown in Table 18 that when the efficacy of 0.4 per cent soapsud was tested against the efficacy of the same nicotine-soap solution (Formula 2) side by side on the same trees the average yields per 100 square meters of crown were 1,215.6 fruits for the first treatment and 1,623.9 fruits for the second treatment, as against 170.2 fruits for the checks or the untreated. In other words, by virtue of the treatments, soapsud increased the yield 7.1 times, while nicotine-soap increased it 9.5 times that of the check. The nicotine-soap spray evidently has shown again better results than the soapsud spray of less concentration (Plate 15, figs. 1 and 2).

In the third series in which 0.4 per cent soapsud was applied on one side of the crown and a less-concentrated nicotine-soap, Formula 4, containing 0.3 per cent soap and 0.05 per cent "Black leaf 40" on the other, with the middle strip of the crown left untreated as check, the soapsud sides produced on the average slightly better results than the nicotine-soap sides (Plate 16, figs. 1 and 2). As shown in Table 19 the soapsud sides had 1,186.7 fruits (increase, 4.1 times), while the nicotine-soap sides had 1,146.7 fruits (increase, 4 times) per 100 square meters of crown as against 285.4 fruits of the checks.

It is interesting to note in these three series the varied responses of the trees to the treatment. While in the first and second series the treatments increased on the average the yields by 5.6-fold and 8.3-fold, respectively, in the third series the increase was but 4-fold. The reason for this discrepancy cannot possibly be due to the difference in the concentrations of the

spray solutions used in as much as, although some variations were made, there was always one basis in common as may be seen by referring to Tables 17, 18, and 19, or to Table 20, series 6, 7, and 8. To what factor then was the variation due? By going over the description of the trees included in the three series, it will be noted that the hopper infestations pertaining thereto were moderate to severe, severe, and moderate, for the first, second, and third series, respectively. Naturally, the greatest damage was suffered by the checks of the second series, followed by the check of the first series, while the checks of the third and last series suffered the least. It is reasonable, therefore, to expect the variation in the corresponding increases in yield accruing from the same or identical treatments. This view seems to afford sufficient grounds for believing that the heavier the hopper infestation, the greater is the increase in yield resulting from spraying. However, there is an exception to this, and that is when heavy or severe infestation occurs as early as the time the inflorescence buds are but 1 to 4 centimeters long, in which case the treated sides may already be severely damaged before any treatment can be applied (Table 21).

This greater increase in the yield in fruits resulting from the treatment of severely infested trees over the checks should not be misconstrued to mean correspondingly larger financial profit in as much as the total average expenses incurred are comparatively higher, being almost twice as much as the first and thrice as much as the third, as shown in Table 20, series 6, 7, and 8.

By converting these increases in yields resulting from the beneficial effects of the different treatments into net profit in terms of pesos and centavos, the following (Table 20, series 6 to 8) are obtained from each carabao tree of 100 square meters crown:

First series: Spraying with 0.5 per cent soapsud, 25.14 as against 17.55 pesos for nicotine-soap, Formula 2.

Second series: Spraying with 0.4 per cent soapsud, 17.41 as against 15.54 pesos for nicotine-soap, Formula 2.

Third series: Spraying with 0.4 per cent soapsud, 19.26 as against 14.92 pesos for nicotine-soap, Formula 4.

The average of the total net profits for these three series, 6, 7, and 8, as shown in Table 20, is 20.60 pesos for the soapsud treatment as against 16 pesos for the nicotine-soap treat-

ment, or a net gain of 4.60 pesos for soapsud over nicotine-soap. It may be seen from the same table, however, that the averages of the total net profits for all the eight series are practically equal; namely, 19.87 pesos for soapsud and 20.97 pesos for nicotine-soap. This should not be taken as the basis for comparison in efficiency in as much as in series 1 to 5 the two spray solution (soapsud and nicotine-soap) were not applied side by side on the same trees, but each was applied side by side with the checks or untreated. Because of the variabilities existing between the producing habits of individual trees even of the same variety, as revealed by many trees observed, some of these series might have been placed on good yielders while others might have been on fair or poor yielders. This might have been the case with series 1, 2, and 3 as compared with series 6, 7, and 8, all of the nicotine-soap series. It may be noted that although treated with the same solution of the same strength, series 2 gave a net profit of 25.76 pesos as against 17.55 and 15.54 pesos for series 6 and 7, respectively.

In the case of the pico variety it is shown in Table 20 that a larger net profit per 100 square meters of crown was realized from soapsud than from nicotine-soap in each and every one of the entire series.

There seems to be sufficient grounds, therefore, to state that, although not as effective as nicotine-soap, soapsud under ordinary conditions is a better spray for the control of the blossom-blight hoppers, principally because it gives, due to its cheapness, a larger net profit on the average, and secondarily because it is practically nontoxic to higher animals, convenient, and readily and safely handled even by inexperienced workers. When the price of mangos is high, however, reaching for instance, two or three times the quotation herein given as generally is the case with an offseason crop, nicotine-soap may prove the better spray to use. The same thing may be said if cost of labor is limited and its cost high, as found in some localities.

SPRAYING TREES WITH SLIGHT INFESTATION OCCURRING LATE AND TREES WITH SEVERE INFESTATION OCCURRING EARLY

In Table 21 is given the comparative yields obtained by spraying with 0.5 per cent soapsud trees with slight infestation occurring late on the one hand, and trees with severe infestation occurring early on the other. Under the column "Yield" it is shown that trees 24, 44, 6, 12, and 45 produced heavy yields

on both the treated and the check sides, while trees 60, 61, 64, and 65 produced on the average barely two hundred fruits each on the sprayed sides and fifteen fruits each on the checks. This would seem to indicate that the treatment did not give beneficial effect to the first five trees while the last four showed great response.

These varying reactions exhibited by the trees to the same treatment may perhaps be explained, at least in part, by the time and volume of the hopper infestation that each had during blooming. This phase was discussed at length under the infestation experiment given in Table 6. It is also shown that tree 44 had but slight infestation, which occurred late and might have been so mild as to cause but insignificant damage and hence the very little difference in the yields between the treated and the check; it is also shown on the other hand that tree 24 had slight infestation and yet the treated side produced almost twice as many fruits as the check, indicating that it responded to the treatment. The other reason may perhaps be the difference in the susceptibility or resistance of the individual trees to the hopper infestation. Hence the great contrast shown between the yields of the treated sides and the checks.

By expressing these yields in monetary gross income the first five trees turned out creditably, while the last four showed poorly. When computed for net profit per 100 square meters of crown interesting results were obtained. Trees 44 and 12 gave a net loss of 0.75 and 2.15 pesos, respectively, showing that they suffered little if any damage from the infestation. On the other hand, all the remaining trees yielded insignificant net profits, with the possible exception of tree 24 which had very slight infestation.

Based on the foregoing results, it may be said in a general way that when infestation by blossom-blight hoppers is slight and occurs late, spraying for immediate returns and profit cannot be assured at the price quoted herein, unless such trees are known to be highly susceptible to the ravages of the infestation. Tree 24 seems to fall under this classification.

The same thing may be said when the infestation is severe and occurs early. If the tree thus infested happens to be fairly highly resistant to the infestation, which seems to be the case with some trees under observation (Plate 17, figs. 1 and 2), spraying would seem to be of little use, because without it many fruits will set and develop to maturity just the same. If the

tree happens to be susceptible, spraying may help in saving some fruits, but the margin of profit in such an operation is generally so meager that it would not pay for the trouble and effort, as in the preceding case.

Therefore, in spraying for the control of the blossom-blight pest the first thing to do is to examine the trees for the infestation. This is better accomplished while the inflorescence buds are only a few centimeters long and before the flower buds begin to show signs of opening. If there be on the average two or more adult hoppers of either species per panicle, spraying should be considered absolutely necessary unless the flower buds already are discolored and damaged at the time due to the early occurrence of the infestation. On the other hand, if the average infestation per panicle is less and occurs when the inflorescences already are fairly developed, spraying may be of no avail except for reducing the sources of infestation for noninfested trees. Knowledge of why and when to spray is obviously of prime necessity to successful spraying. Similarly, keen observation of the habits and idiosyncrasies of the individual mango trees may, perhaps, help in avoiding unnecessary and wasteful operations.

OTHER FACTORS GENERALLY ASSOCIATED WITH BLOSSOM-BLIGHT IN CAUSING MANGO FAILURE

Together with the blossom-blight hoppers there are several factors of minor importance generally associated with mango failure, principal among which are the anthracnose disease caused by the *Gloeosporium* stage of *Glomerella cingulata* (Stonem.) S. and v. S. and the tip-borer pest caused by *Chlumetia transversa* Walker.

THE ANTHRACNOSE

The anthracnose disease, caused by a fungus known as *Glomerella cingulata* (Stonem.) S. and v. S., as reported by Palo(4) is not as serious a factor in mango failure as was thought at first. It may, however, occur in an alarming proportion and cause serious damage to the crop when favorable weather conditions obtain. Plenty of moisture and warm atmosphere or high humidity seem to be essential for its proper development. Owing to the fact that, unless the trees are forced to bloom by smudging during the more or less wet months of October, November, and December, the flowering season for mangos by nature coin-

TABLE 22.—*Weather observation from January to June, 1932.*[a]

Date.	Observations.	Total rain in each month.	
		in.	*mm.*
1932			
Jan. 13	Shower shortly after midday	0.04	1.1
Feb. 1	Shower in the afternoon		
Feb. 12	do		
Feb. 28	Shower for about 15 minutes at about midnight	0.03	0.9
Mar. 16	Shower at night		
Mar 23	Shower for 2 hours before midday		
Mar. 29	Shower for 15 minutes shortly after midday	0.21	5.4
Apr. 22	Slight shower at night	0.02	0.5
May 12	Shower for about 1 hour before midday and continuous shower at night		
May 13	Rain for 30 minutes in the afternoon and alternate rain and shower at night		
May 14	Shower for 30 minutes before midday		
May 15	Rain for 3 hours in the afternoon		
May 23	Shower for 30 minutes shortly after midday and rain for 1 hour early in the evening		
May 26	Rain for about 1 hour in the afternoon		
May 28	Shower at night		
May 29	Rain for 25 minutes in the afternoon		
May 31	Rain in the morning and at night	8.49	215.6
June 1	Shower at night for about 10 minutes		
June 2	Rain for about 30 minutes in the afternoon		
June 3	Rain for about 25 minutes in the afternoon		
June 5	Shower for about 5 minutes in the morning		
June 6	Rain for 40 minutes in the afternoon		
June 7	Shower for 10 minutes in the afternoon		
June 8	Rain for 15 minutes in the morning and for about 1 hour in the afternoon		
June 9	Shower for 15 minutes before midday and for about 1 hour in the afternoon		
June 10	Shower in the afternoon		
June 11	Continuous rain and showers the whole day		
June 12	Showers in the morning and in the afternoon		
June 13	Shower for 25 minutes shortly after midday		
June 14	Rain for 30 minutes in the afternoon		
June 15	Rain for 25 minutes early in the day		
June 16	Shower for 35 minutes early in the evening		
June 17	Rain for 1 hour shortly after midday		
June 20	Shower for 20 minutes in the afternoon		
June 23	Shower for 10 minutes early in the day		
June 24	Rain for 30 minutes early in the evening		
June 26	Rain and showers for 4 hours in the morning		
June 28	Shower for 4 hours in late afternoon and evening		
June 29	Rain for 30 minutes in the afternoon and for nearly 2 hours in the evening		
June 30	Rain for 45 minutes in the morning and 25 minutes in late afternoon	8.40	213.6

[a] These figures represent the total rainfall at the Alabang rice experiment station and were obtained through the kindness of officials of the Philippine Weather Bureau.

cides with the dry season or months of practically no rain, from January to April, a severe occurrence of this disease is possible but not probable. In the summer of 1932, in spite of the occasional rain that fell in Muntinlupa and vicinity, not a single case of anthracnose infection was observed. Towards the end of May, 1932, soon after a week of more or less continuous rain and shower beginning on the 12th, a serious outbreak of the disease was noted on a number of mango trees flowering late in the season and having the young fruits just starting to set.

In view of the foregoing observations it would seem justifiable to state in a general way that unless there is a more or less continuous rainfall for several days, which is rather unusual in January to April when the mangos are in flower, no fear should be entertained of a severe infection by anthracnose disease in Muntinlupa and vicinity or in any other locality having similar or identical climatic conditions (Table 22). Its control or prevention, when likely to occur in an alarming proportion is, however, worthy of thoughtful consideration. The necessity for this may perhaps be felt the more when smudging is resorted to in forcing the trees to flower during the off-season, which is generally attended by frequent rainfalls.

It might be mentioned in this connection that the results of preliminary experiments, coupled with observational facts, tend to disprove the common belief that an occasional rainfall when mangos are in flower is synonymous with mango failure. If rainfall is truly and directly harmful to the mango flowers, the average crop per tree produced from flowers during May when there is abundant rain must necessarily be reduced, but actual observations in the field indicate the contrary. It may become inimical, however, under certain conditions, as in the presence of anthracnose disease which is favored by moisture. Owing perhaps to the microscopic nature of the organism causing this disease which occurs invariably and only in the presence of abundant moisture supplied by a more or less continuous rain and shower for several days at least, casual observers are led to believe that the resulting damage to the mango crop is directly and wholly due to the rain which favors the rice crop on the other hand. Rain or abundant moisture in the absence of the pathogenic organism appears, therefore, as harmless to the mango crop as the anthracnose disease in the absence of adequate moisture for its proper development.

THE TIP-BORER

The "tip-borer" pest, the larva of the moth *Chlumetia transversa* Walker, is another factor to consider in solving the problem of mango failure, as it is more or less constantly associated with blossom-blight hoppers. The fact that the larva of this insect pest attacks the mango generally by entering at or about the apices of the inflorescence, tunneling its way into the basal part, thereby forming a cavity in it and causing the tops of the affected parts to shrivel and die, but often leaving the lateral branches and flower buds apparently unharmed, may explain why, according to field observations, moderate infestation by this pest is of no grave concern. However, when it occurs with severity the necessity for studying means for its control may become obvious.

LIGHT-TRAPPING EXPERIMENT

Light trapping has been practiced since time immemorial as a means of catching nocturnal lepidopterous insect pests that are positively phototropic. It is not, however, as popular as either spraying or dusting. It is certain, of course, that in the majority of cases profits are forthcoming in less time and with little expense by either spraying or dusting, but there are times when light trapping may be resorted to with advantage. In the present case, should the hoppers prove to be light loving, light trapping may, perhaps, be used to advantage in places where inadequate water supply is a handicap to spraying operations. It is for this reason that the following preliminary experiment was conducted.

Each of two lanterns was placed in a basin of water to which a little kerosene was added. Each basin was located under a mango tree infested by a moderate number of adult hoppers, preponderantly *I. clypealis*, each basin being placed on a flat surface of a lateral branch about 2 meters from the ground. At about 6 p. m. May 5, 1932, the lanterns were lighted and left in place overnight. The following morning each basin was examined for the insects caught, particularly blossom-blight hoppers. This was repeated under the same trees on five different nights, when the moon appeared at different phases; namely, May 20, 27, 31, and June 4, 1932. The results are given in Table 23.

The largest catch was May 5, when there was no moon; while the smallest catch was May 20, when there was a full moon. The total catch of both *Idiocerus niveosparsus* and

TABLE 23.—*Results of light trapping.*

Date observed.	Phase of the moon.	Caught in two traps.	
		Idiocerus clypealis.	*Idiocerus niveosparsus.*
1932			
May 5	No moon	215	1,050
May 20	Full moon	40	36
May 27	Last quarter	174	250
May 31	Half quarter	283	269
June 4	New moon	324	422
Total catch		1,036	2,027

I. clypealis is as follows: 1,265 adults May 5, when there was no moon; 76 adults May 20, when there was a full moon; 424 adults May 27, when the moon was at last quarter; 552 adults May 31, when the moon was at half quarter; and 746 adults June 4, when there was a new moon and the night was practically as dark as when there was no moon. The total catch of each species was 1,036 for *I. clypealis* and 2,027 for *I. niveosparsus.* Numerous other insects were also trapped.

These results would seem to indicate that, like many other insect pests, *Idiocerus clypealis* and *I. niveosparsus,* particularly the latter, are attracted by light although not strongly positively phototropic; that the darker the night, the better for the trapping; and that *I. niveosparsus* is better attracted by light or more positively phototropic than *I. clypealis.* This is economically beneficial because, as observed in the field and proved by experiment, *I. niveosparsus* is the more destructive and the more persistent of the two species.

Finally, light trapping, if used judiciously and early enough to get the adult hoppers before they have an opportunity to lay eggs in the inflorescences, may help reduce materially the damage caused by them, particularly the large species, *I. niveosparsus.* It may prove useful especially for isolated trees or groves where there is little chance of reinfestation from the neighborhood, and in places where lack of water supply is a handicap to spraying operations.

SUMMARY AND CONCLUSION

1. Blossom-blight is the most destructive insect pest of the mango, *Mangifera indica* Linnæus, in the Philippines. It is caused by two species of leaf-hoppers, *Idiocerus niveosparsus*

Léthierry and *I. clypealis* Léthierry. It apparently attacks with equal severity the carabao, pico, and señora varieties as well as many other unidentified hybrids. The pahutan variety of *Mangifera altissima* Blanco is also infested, but the crop does not seem to suffer at all.

2. It was found in Cavite, Rizal, Bulacan, Batangas, Laguna, Bataan, Pampanga, Tarlac, Zambales, Nueva Ecija, and Pangasinan Provinces, causing on the average 75.32 per cent damage to the mango crop in the first three provinces. There are indications, therefore, that the bright future of mango, admittedly the premier dessert fruit of the Philippines, is being seriously threatened by this noxious pest.

3. Whether this pest is indigenous to the Islands or not is unknown.

4. The percentage of perfect flowers does not seem to be in any way related to mango failure. This is based on the fact that the carabao mango was found to have on the average 45.2 per cent perfect flowers as against 25.3 per cent of the pico variety, and yet practically they are equally productive; the former, owing to its superior qualities and larger size, commands a better price and therefore gives a greater net profit from the treatment.

5. The hoppers may damage the crop in two ways. First, owing to the heaviness of egg-laying, physical injury is inflicted on the flower stems as well as the individual flower buds, thereby causing them to wither and drop. Second, the nymphs which hatch in large numbers, crowd together among the florets and with their proboscis pierce the tissues of the flower stems and draw the sap. Most of the sap thus sucked is, however, excreted after a certain amount of digestion as droplets of sticky sweetish fluid commonly known as honeydew. This gives rise to the sooty mold that causes partial blackening of the infested trees.

6. In severe cases of infestation it is not unusual to find all of the inflorescences withered and the young fruits conspicuous by their absence, thereby causing a total loss of the crop.

7. The large species of blossom-blight hopper is *Idiocerus niveosparsus* Léthierry. It is wedge-shaped, cinnamon-drab, and measures 3.8 to 4 millimeters long.

8. *Idiocerus niveosparsus* has five nymphal stages, covering a period of about seven and one-half days. The nymphs live on the flower flushes during the flowering season and on the leaf flushes during the offseason. The eggs are cigar-shaped, 1.2

millimeters long and 0.2 millimeter thick. They are laid in the flower stems and flower buds during the blooming season, and in the midribs of tender leaves generally on the lower surface during the offseason. They hatch in a little over four days, so that the total span of its life from the laying of the eggs to the emergence of the adults is about eleven and one-half days.

9. There are, on the other hand, but four nymphal stages of *Idiocerus clypealis* covering about nine and one-half days. The nymphs live exclusively on the inflorescences. The eggs are cigar-shaped 0.75 millimeter long and 0.1 millimeter thick. They are laid exclusively in the flower buds, which may explain why no copulation of this species takes place during the offseason or as soon as the flowers have started to wither. They hatch in about four and one-half days, so that the life cycle from the laying of the eggs until the emergence of the adults is about fourteen days.

10. The adults of both species of blossom-blight hoppers seem to be most active when the mangos are in flower; that is, from January to April, or perhaps even as early as October to December when the trees are forced to bloom by smudging. Beginning the latter part of May or early in June when there are no more flowers, the small species, *Idiocerus clypealis,* may be found living, at least in part, on various plants, while the large species, *Idiocerus niveosparsus,* apparently remains all the year round on mangos. Unlike the small species the large species was found to lay eggs, although to a limited extent, even during the offseason whenever there is suitable food material in the form of leaf flushes.

11. A fungous parasite (perhaps *Isaria* sp.) was found attacking and killing the adults of *Idiocerus clypealis,* pasting them on the nether side of the leaves. There are, besides, several predators (ladybird beetles, ants, and spiders) that feed on the nymphs and eggs of both species. With all this, there seems to be a possibility of reducing the damage caused by the hoppers, by biological means.

12. The large species, *Idiocerus niveosparsus,* proved to be more destructive than the smaller species, *I. clypealis,* but its superior destructiveness is often overshadowed by that of the latter due to its overwhelming preponderance.

13. Any infestation having on the average two adults or more per panicle, whether by *Idiocerus clypealis* or *I. niveosparsus* or

both, needs spraying. Lighter infestation, unless by the larger species or unless occurring as early as when the inflorescence buds are still developing, may not need spraying except for the purpose of reducing the source of infestation for noninfested trees.

14. Of the nicotine-soap solution of various concentrations tried Formula 1, containing 0.36 per cent soap and 0.12 per cent "Black leaf 40" (nicotine sulphate), proved to be the most effective and the most economical for spraying the carabao variety. For the pico variety, which seems to possess a more delicate blossom, Formula 4, containing 0.3 per cent soap and 0.05 per cent "Black leaf 40," showed the best results.

15. As a contact insecticide, soap was found to be more effective than "Black leaf 40," indicating that it is the main active principle in nicotine-soap solution. The right combination of the two (Formula 1) proved, however, to be more effective than either one of the same strength taken individually.

16. The Chinese yellow laundry soap, followed closely by the Señorita soap and resin soap, proved to be the most effective and the cheapest of the brands tested.

17. Soapsud of 0.5 per cent concentration was found more effective and economical than soapsud of 0.4 per cent concentration for spraying the carabao variety, while the reverse proved to be true for the pico variety.

18. Spraying with 0.5 per cent soapsud increased on the average the yield of the carabao variety four and seven-tenths times that of the untreated or the check (813.2 fruits of the treated vs. 172.4 fruits of the check) at a total expense of 0.00204 peso per fruit; while spraying the same with nicotine-soap, Formula 1, increased the yield five times that of the check (871.5 fruits of the treated vs. 172.4 fruits of the check) at a total expense of 0.00666 peso per fruit.

At this increase of the yield and cost of spraying a fruit and at a selling price of 3 pesos a kaing of fruits, the net profit obtained from a carabao tree of 100 square meters of crown was 20.60 pesos for the soapsud treatment and 16 pesos for the nicotine-soap treatment, or a difference of 4.60 pesos in favor of soap. The market price of the crop will, of course, invariably affect the net gain.

19. Stress is placed upon the right time of spraying and the thoroughness of application. Haphazard treatments can only reap a crop of failure and consequently unnecessary expense.

20. Spraying trees with very slight infestation occurring late, trees with severe infestation occurring early, and trees known to have an exceptionally high degree of resistance to the blossom-blight attack, is not advisable unless for the purpose of reducing the source of new infestation.

21. The old common belief that the advent of rainfall when mangos are in flower is synonymous with mango failure is explained. The rain is destructive to the mango crop in that moisture favors the anthracnose disease, *Glomerella cingulata* (Stonem.) S. and v. S., which attacks and kills the flowers as well as the young tender fruits.

22. In places where lack of water supply is a handicap to spraying operation, light trapping as a means of minimizing the ravages caused by blossom-blight hoppers, particularly the large species, *Idiocerus niveosparsus* Léthierry, which proved to be fairly well attracted to light, or positively phototropic, may be used to advantage. This method may prove especially useful to isolated trees or groves where there is a little chance of reinfestation from the neighborhood.

23. Crossing the carabao mango with the pahutan so as to obtain a hybrid possessing the desirable qualities of the carabao fruit and the exceptional resistance of the pahutan to the blossom-blight pest may offer an opportunity to evolve a more or less permanent control for the pest.

24. Obtaining the scions for grafting or budding purposes from the carabao trees that have persistently shown a high degree of resistance to the pest would seem to be another means that might prove helpful or effective in minimizing the ravages of the pest.

25. The results herein presented, covering but one season's observation and experimentation, are not meant to be taken as so final and conclusive as to be applicable to other seasons. Further investigation of the subject at different seasons may bring about some slight modification of the views expressed herein; but there are some facts discovered that lead to advice which, if followed, will help the mango growers save much of their crop.

RECOMMENDATIONS

On the basis of the foregoing observations and experiments the writers recommend the following control measures.

SPRAYING [5]

In view of the fact that under field conditions the hopper infestation varies to a certain extent as to severity and age of the inflorescences when it occurs, which, together with the individual characteristic of the mango trees, constitutes the factor that determines the advisability or not of spraying for immediate financial profit, it is necessary first to examine carefully the trees for the infestation. This should be accomplished before the flower buds show signs of opening, or about ten days after the emergence of the inflorescence buds. During egg-laying the adult hoppers are quite tame and may be observed on the flowers without difficulty.

When there are on the average two or more adults of either species or both per panicle, spraying should be considered absolutely necessary unless the flower buds are already discolored and damaged at the time resulting from the early occurrence of the infestation, or unless the particular tree so infested is known to be of the highly resistant type; that is, one which produces a good crop every time it blossoms profusely, the heavy hopper infestation notwithstanding. On the other hand, if the hopper infestation per panicle is less and occurring when the inflorescences are pretty well developed or beginning to open, spraying may be of no avail unless for the purpose of reducing

[5] The spray solutions may be prepared in the following manner:

To make the stock solution of 0.5 per cent soapsud for 100 liters of the spray solution, dissolve 500 grams of Chinese yellow laundry soap sliced into small pieces in 10 liters of hot water (70° to 80° C.) in a gasoline or petroleum can, stirring the water once in a while. As soon as all particles of soap are dissolved dilute the solution with enough water in a big container (50-gallon barrel) to make 100 liters of 0.5 per cent soapsud spray solution ready for use.

For 0.4 per cent soapsud, follow exactly the same procedure, but use 400 grams of soap for the same amount of spray solution.

Nicotine-soap, Formula 1, containing 0.36 per cent soap and 0.12 per cent "Black leaf 40" (nicotine sulphate), may be prepared in the following manner: To prepare the stock solution for 100 liters of spray solution, dissolve 360 grams of Chinese yellow laundry soap, then add to the solution in a large container (50-gallon barrel) 120 cubic centimeters of "Black leaf 40" and dilute it with enough water to make 100 liters of Formula 1 nicotine-soap spray solution ready for use.

Nicotine-soap, Formula 4, containing 0.3 per cent soap and 0.05 per cent "Black leaf 40," may be prepared by following exactly the same procedure as the preceding but using only 300 grams of soap and 50 cubic centimeters of "Black leaf 40" for the same amount of the spray solution, or 100 liters.

the source of infestation for non-infested trees. Knowledge of why and when to spray is obviously of prime necessity to successful spraying. Similarly, keen observation of the habits and idiosyncrasies of the individual mango trees may help to avoid unnecessary and wasteful operations.

The approximate time and volume of infestation once determined, the next thing to do is to examine the inflorescences for the presence of nymphs or young wingless hoppers from first to third stages appearing generally thirteen to fourteen days after the emergence of the inflorescences, or a day or two after the flower buds have started opening. This may be accomplished easily by holding the base of the panicle in the hand and agitating it for a half minute or so. The nymphs may be seen moving down the flower stems. Do this on several panicles so as to gain a fair idea of the species present and severity of infestation.

Use 0.5 per cent soapsud for the carabao variety and 0.4 per cent soapsud for the pico variety, which evidently possesses a more-delicate inflorescence and hence is susceptible to the toxic effect of the spray. Apply the spray with thoroughness, using Gould's or Demming's hand spray pump, or if available, a power spray pump provided with 10 to 20 meters of rubber hose tied to a bamboo rod. If the trees are tall, use a bamboo ladder with props in spraying the tops, directing the solution against the flowers at all angles to ensure the complete wetting of all the nymphs in the inflorescences, upon which greatly depends the efficacy of the treatment. Repeat the spraying four times at two-day intervals if the large species, *Idiocerus niveosparsus* Léthierry, or both species are present. If the small species, *I. clypealis* Léthierry, is present alone, repeat the spraying only three times at three-day intervals, wetting not only the inflorescences but also the lower surfaces of the leaves just below the panicles where most of the largest wingless hoppers or nymphs generally hide prior to their last molting. After each application the inflorescences should be examined to determine how thoroughly the spray had been applied as may be indicated by the amount of kill. This will guide the operator in his next move.

Reinfestation by the large species of hoppers, *Idiocerus niveosparsus* Léthierry, may increase the number of sprayings. This usually occurs after the flowers have withered and the young fruits are set.

When there are indications that the price of mangos will be high, as for instance about 10 pesos per kaing, the use of nicotine-soap spray may prove as economical as, if not more so than, the soapsud spray, and hence preferable. The same thing may be said in places where the cost of labor is high and the right kind of soap not readily available.

For spraying the carabao variety use Formula 1, containing 0.36 per cent soap and 0.12 per cent "Black leaf 40" (nicotine sulphate); for spraying the pico variety use Formula 4, containing 0.3 per cent soap and 0.05 per cent "Black leaf 40," following in either case the same procedure as that given for soapsud.

Stress is placed upon the importance of arousing community spirit in pushing the campaign against this noxious pest to a successful end. Unless each grower adopts the necessary steps to stamp out and free his grove from the pest, the desired goal will be difficult to attain.

LIGHT TRAPPING

In places where inadequate water supply is a handicap to spraying operation, light trapping as a means of minimizing the ravages caused by the hoppers, particularly the larger species, *Idiocerus niveosparsus* Léthierry, which proves to be fairly well attracted to light, or positively phototropic, may be used to advantage. This method may prove especially useful to isolated trees or groves where there is little chance of reinfestation from the neighborhood.

The trap may be set by placing a lighted lantern in the middle of a large basin with water to which a little kerosene has been added, and placing the basin on a stand 1 to 2 meters above the ground under the infested tree early in the evening when there is no moon or when it is practically dark the whole night and leaving it there till morning. Strain out the catch every day before setting out the trap anew. Do this for about seven to ten days beginning the last quarter, to coincide with dark nights and with smudging, or about a week before the inflorescence buds come out so as to prevent the hoppers from laying eggs thereon.

It should be borne in mind that light trapping during bright moonlight is as ineffective as light trapping after the eggs have been laid.

BREEDING AND SELECTION

The advisability of breeding for resistance should be given the necessary stimulus and support. Crossing the carabao mango with the pahutan so as to obtain a hybrid possessing both the desirable qualities of the carabao fruit and the resistance of the pahutan to the pest, may offer an opportunity to evolve a more or less permanent control for the pest. Of course, this may require several years before any definite result is obtained owing to the late-maturing characteristic of the mangos; but the delay in time is nothing compared with the lasting benefits that may accrue therefrom.

In grafting and budding, the use of scions from the carabao trees which have persistently shown a high degree of resistance to this noxious pest may prove helpful in minimizing its ravages.

The modern conception of disease and pest control hinges on this mode of attack.

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ILLUSTRATIONS

PLATE 1

FIG. 1. A flower bud of carabao mango showing six eggs in three pairs, of *Idiocerus clypealis*. The bud was purposely opened to illustrate the position of the eggs as they are laid between the sepals and petals; about × 5.

2. *Idiocerus clypealis*, first nymphal stage, about × 5.
3. *Idiocerus clypealis*, second nymphal stage, about × 5.
4. *Idiocerus clypealis*, third nymphal stage, about × 5.
5. *Idiocerus clypealis*, fourth nymphal stage, about × 5.
6. *Idiocerus clypealis*, adult and last stage, about × 5.
7. A tip of a fully developed carabao mango inflorescence showing infestation by both species of the hoppers. Note the presence of *Idiocerus clypealis* and *Idiocerus niveosparsus* of different stages; about × 1.
8. A longitudinal section of a flower stem showing a couple of *Idiocerus niveosparsus* eggs in a natural position; about × 5.
9. *Idiocerus niveosparsus*, first nymphal stage, about × 5.
10. *Idiocerus niveosparsus*, second nymphal stage, about × 5.
11. *Idiocerus niveosparsus*, third nymphal stage, about × 5.
12. *Idiocerus niveosparsus*, fourth nymphal stage, about × 5.
13. *Idiocerus niveosparsus*, fifth nymphal stage, about × 5.
14. *Idiocerus niveosparsus*, adult and last stage, about × 5. (Colored drawings by M. Ligaya.)

PLATE 2

FIG. 1. A fully developed inflorescence of carabao mango free from the blossom-blight infestation; about × 0.2. (Photograph by V. F. Ferrer.)

2. A cluster of carabao mango inflorescences representing a typical specimen of the mango blossom-blight pest and showing complete destruction resulting from severe infestation. Note the sooty appearance of the leaves owing to the growth of mold on the honey-dew excreted by the hoppers; about × 0.2. (Photograph by V. F. Ferrer.)

PLATE 3

FIG. 1. A five-day-old mango inflorescence bud showing early infestation by the hoppers. Note the adults of *Idiocerus clypealis* presumably laying eggs in the flower buds; about × 0.8. (Photograph by F. B. Serrano.)

FIG. 2. A group of carabao mango inflorescences of different stages of development showing early infestation by the hoppers; left, the stage at which most of the infestation takes place; middle, the stage at which some infestation takes place; and right, the stage at which very little infestation takes place; about × 1. (Photograph by C. S. Angbengco.)

PLATE 4

FIG. 1. A pico mango inflorescence showing more or less complete destruction of the flowers resulting from early infestation by both species. Note the presence of the nymphs of various stages as well as the growth of the sooty mold on the surface of the leaf on the left side; about × 0.8. (Photograph by V. F. Ferrer.)

2. A carabao mango inflorescence showing an advanced stage of severe infestation by both species. Note four young fruits that survived and might have developed to maturity. The more or less complete blackened appearance of the leaves on account of the abundant growth of the mold on the honey-dew is a sure index to the heaviness of the hopper infestation; about × 0.2. (Photograph by V. F. Ferrer.)

PLATE 5

FIG. 1. A pico mango inflorescence severely infested by *Idiocerus niveosparsus.* Note the nymphs of different stages on the flower stems; about × 0.8. (Photograph by F. B. Serrano.)

2. A carabao mango inflorescence severely infested by *Idiocerus niveosparsus.* Note the nymphs of different stages on the flower stems; about × 0.8. (Photograph by F. B. Serrano.)

PLATE 6

FIG. 1. A carabao mango inflorescence bud just beginning to open. No hopper infestation has been observed to take place earlier than and up to this stage of development; about × 1. (Photograph by V. F. Ferrer.)

2. A partial view of a pico tree showing paper bags and celluloid cylinders inclosing young inflorescence buds for the study on the life history of *Idiocerus clypealis* and *Idiocerus niveosparsus;* about × 0.025. (Photograph by F. B. Serrano.)

PLATE 7

FIG. 1. A new leaf flush of carabao mango showing the exuviæ of *Idiocerus clypealis.* Note that practically all face toward the bases of the leaves; about × 0.5. (Photograph by C. S. Angbengco.)

2. A much enlarged leaf of fig. 1 to show better the exuviæ and the newly molted alults; about × 1. (Photograph by C. S. Angbengco.)

PLATE 8

FIG. 1. Three carabao mango leaves showing dead adult *Idiocerus clypealis* resulting from parasitism by a fungous parasite. Note creeping mycelial growth of the fungus covering and pasting the hoppers fast onto the nether side of the leaves; about × 1.2. (Photograph by C. S. Angbengco.)

2. Pieces of the leaves of various plants on which adults of *Idiocerus clypealis* are shown to be parasitized by the same fungus as in fig. 1; about × 1. (Photograph by C. S. Angbengco.)

a, Mango, *Mangifera indica* Linn.
b, Tampoy, *Eugenia jambos* Linn.
c, Chinese litchi, *Litchi sinensis* Sonn.
d, Gumamela, *Hibiscus rosasinensis* Linn.
e, Guayabano, *Anona muricata* Linn.
f, Achuete, *Bixa orellana* Linn.
g, Jackfruit, *Artocarpus integra* (Thunb.) Merr.
h, Breadfruit, *Artocarpus communis* Forst.
i, Calamunding, *Citrus mitis* Blanco.
j, Lucban, *Citrus decumana* Murr.

PLATE 9

FIG. 1. A close-up view of two celluloid cylinders showing inclosures of carabao mango inflorescences used for artificial infestation experiments; about × 1/8. (Photograph by F. B. Serrano.)

2. A group of celluloid cylinders with inclosures of carabao mango inflorescences artificially infested by *Idiocerus clypealis*, as given in Table 7, series 3; about × 1/7. (Photograph by C. S. Angbengco.)

a, Showing complete destruction resulting from infestation by ten adults. No fruit.
b, Showing practically complete destruction resulting from infestation by five adults. Only one fruit.
c, Showing partial destruction resulting from infestation by two adults. Five young fruits.
d, Showing the check with many fruits resulting from non-infestation.

PLATE 10

FIG. 1. A blooming pico tree about 15 meters high being sprayed by four men with two hand spray pumps. Note one of the operators on top of a 9-meter ladder with props. This is a demonstration of how tall trees can be sprayed for blossom-blight control. Note pump below the ladder with its nozzle pointing against the tip of the panicle which is a sure way of wetting all the parts of the inflorescence; about × 1/100. (Photograph by V. F. Ferrer.)

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FIG. 2. A close-up view of fig. 1, to better illustrate the way spraying should be done. Note volume of solution striking the flowers directly and dripping therefrom, indicating complete and thorough application; about × 1/25. (Photograph by V. F. Ferrer.)

PLATE 11

FIG. 1. A carabao tree sprayed with nicotine-soap, Formula 1, on the left side, leaving the right side untreated as check. Note difference in the number of fruits that matured on each side; about × 1/50. (Photograph by F. B. Serrano.)

2. As in fig. 1, but with the entire crown sprayed with nicotine-soap, Formula 2; about × 1/50. (Photograph by F. B. Serrano.)

PLATE 12

FIG. 1. A pico tree sprayed with 0.5 per cent soapsud on the left side, leaving the right side unsprayed as check; about × 1/60. (Photograph by F. B. Serrano.)

2. A carabao tree with the entire crown sprayed with 0.5 per cent soapsud; about × 1/30. (Photograph by F. B. Serrano.)

PLATE 13

FIG. 1. A pico tree sprayed with 0.4 per cent soapsud on the left side, leaving the right side unsprayed as check; about × 1/30. (Photograph by F. B. Serrano.)

2. A señora tree with the entire crown sprayed with 0.4 per cent soapsud; about 1/70. (Photograph by V. F. Ferrer.)

PLATE 14

FIG. 1. A carabao tree with the left side sprayed with 0.5 per cent soapsud and the right side sprayed with nicotine-soap, Formula 2; about × 1/40. (Photograph by C. S. Angbengco.)

2. As in fig. 1; about × 1/70. (Photograph by C. S. Angbengco.)

PLATE 15

FIG. 1. A carabao tree with the left side sprayed with 0.4 per cent soapsud and the right side sprayed with nicotine-soap, Formula 2; about × 1/65. (Photograph by F. B. Serrano.)

2. A carabao tree not sprayed as check; about × 1/65. (Photograph by F. B. Serrano.)

PLATE 16

FIG. 1. A carabao tree with the left side sprayed with 0.4 per cent soapsud; the middle part not sprayed as check, and the right side sprayed with nicotine-soap, Formula 4. Note difference in the number of fruits at setting; about × 1/25. (Photograph by F. B. Serrano.)

FIG. 2. A carabao tree treated as in fig. 1. Note abundance of matured fruits on both sides and their scarcity at the middle; about × $\frac{1}{75}$. (Photograph by F. B. Serrano.)

PLATE 17

FIG. 1. A panicle of a carabao mango showing many young fruits borne in spite of the moderate to severe infestation by the blossom-blight pest; about × ½. (Photograph by V. F. Ferrer.)

2. A carabao tree showing a fairly heavy crop in spite of the moderate to severe infestation by the blossom-blight pest. This would appear to be possessed of some degree of resistance to infestation; about × $\frac{1}{75}$. (Photograph by F. B. Serrano.)

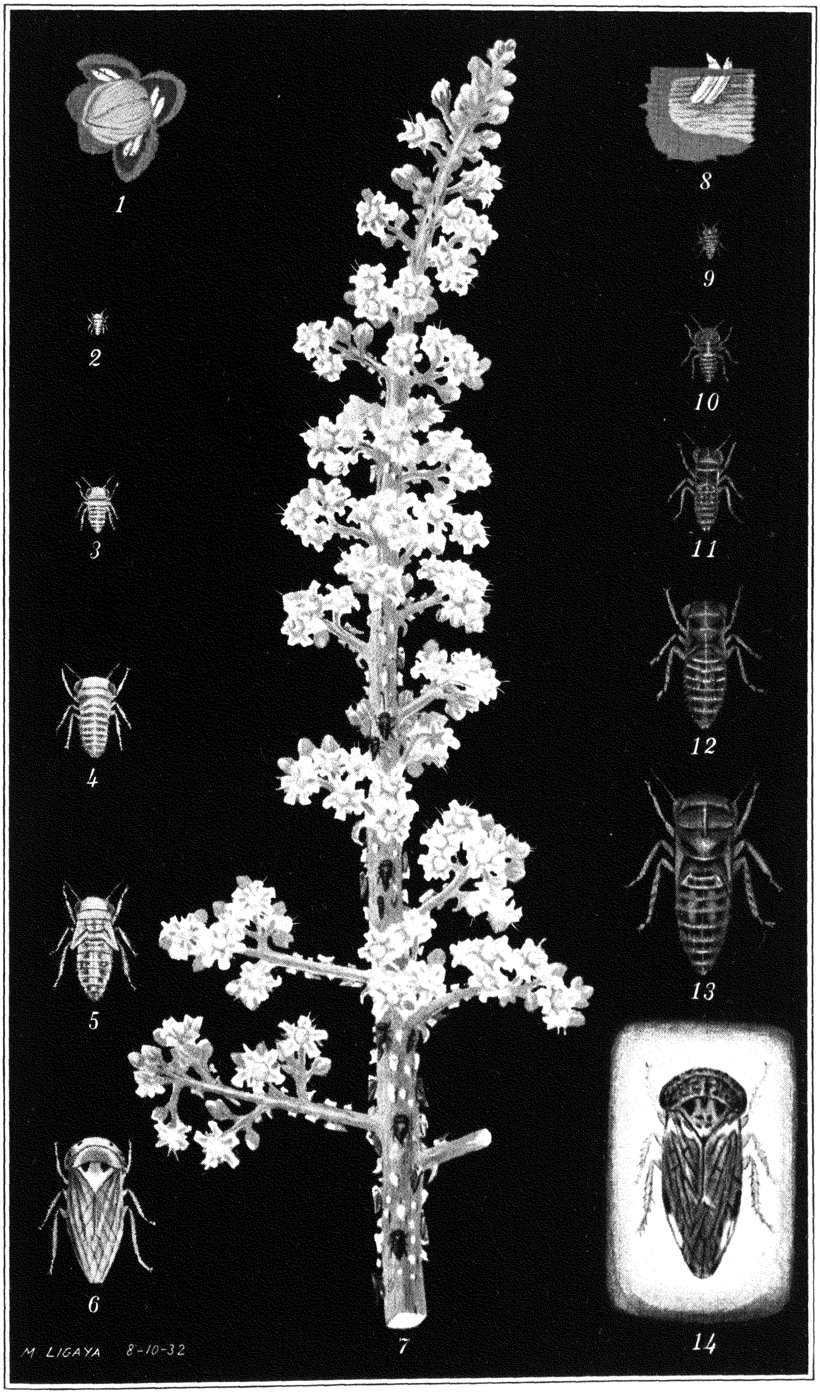

PLATE 1.

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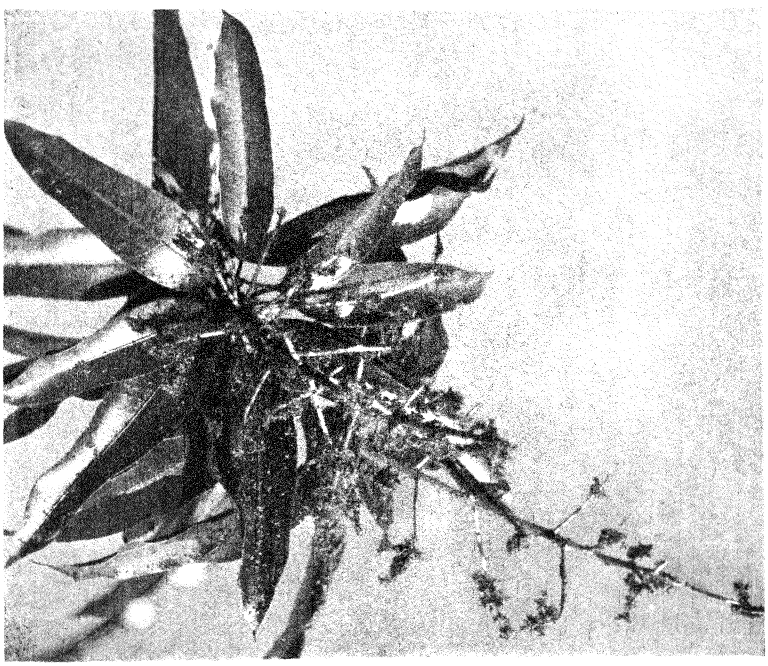

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PLATE 2.

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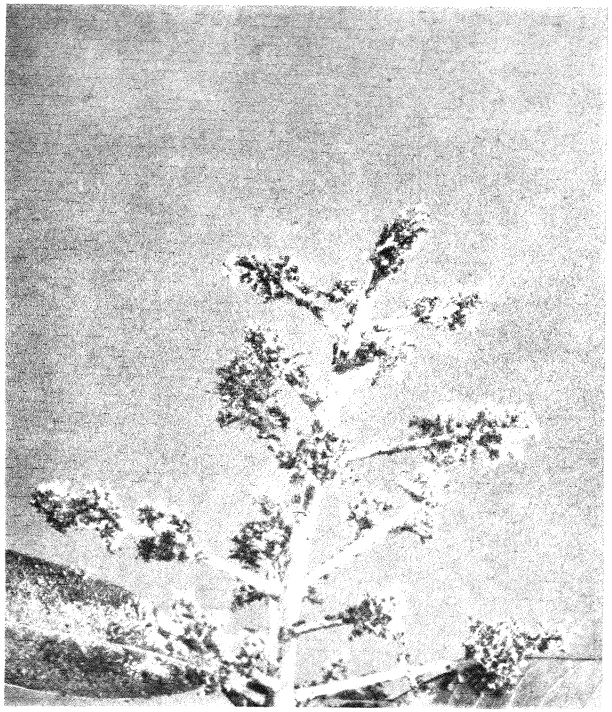
PLATE 3.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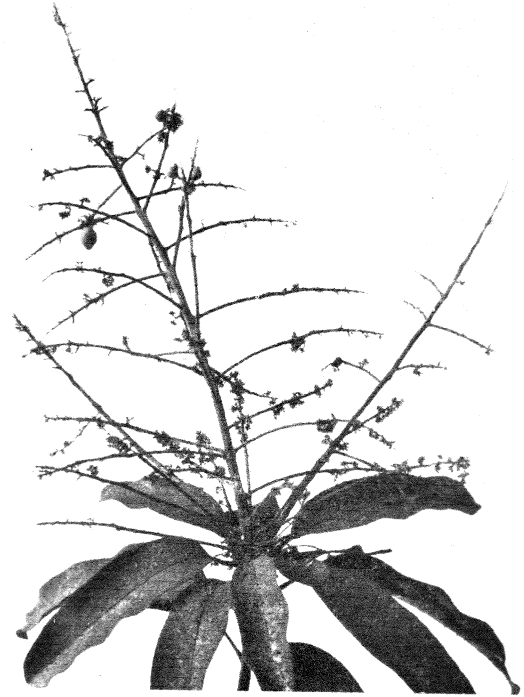
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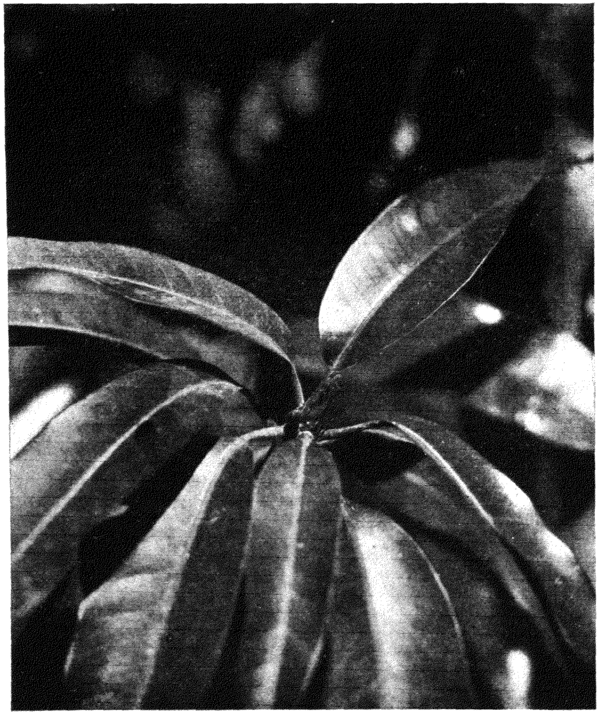
PLATE 4.

PLATE 5.



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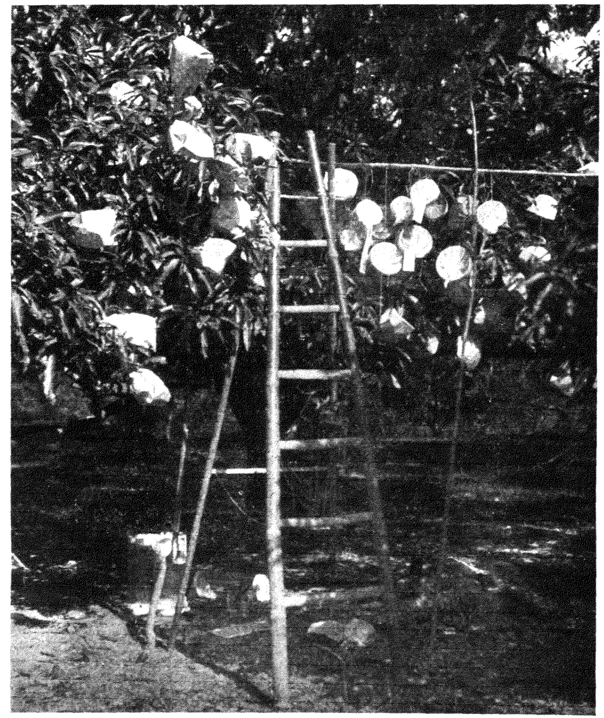

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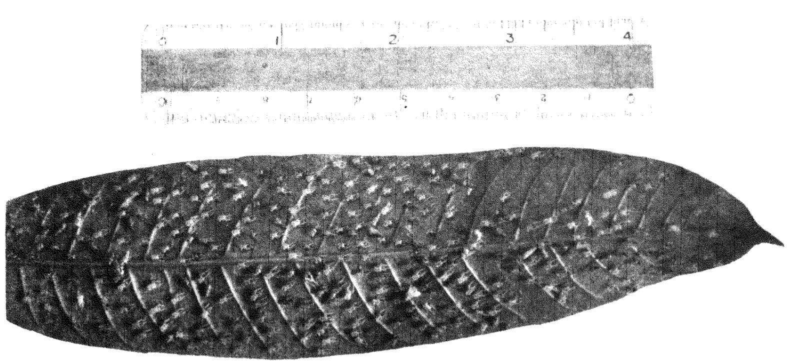

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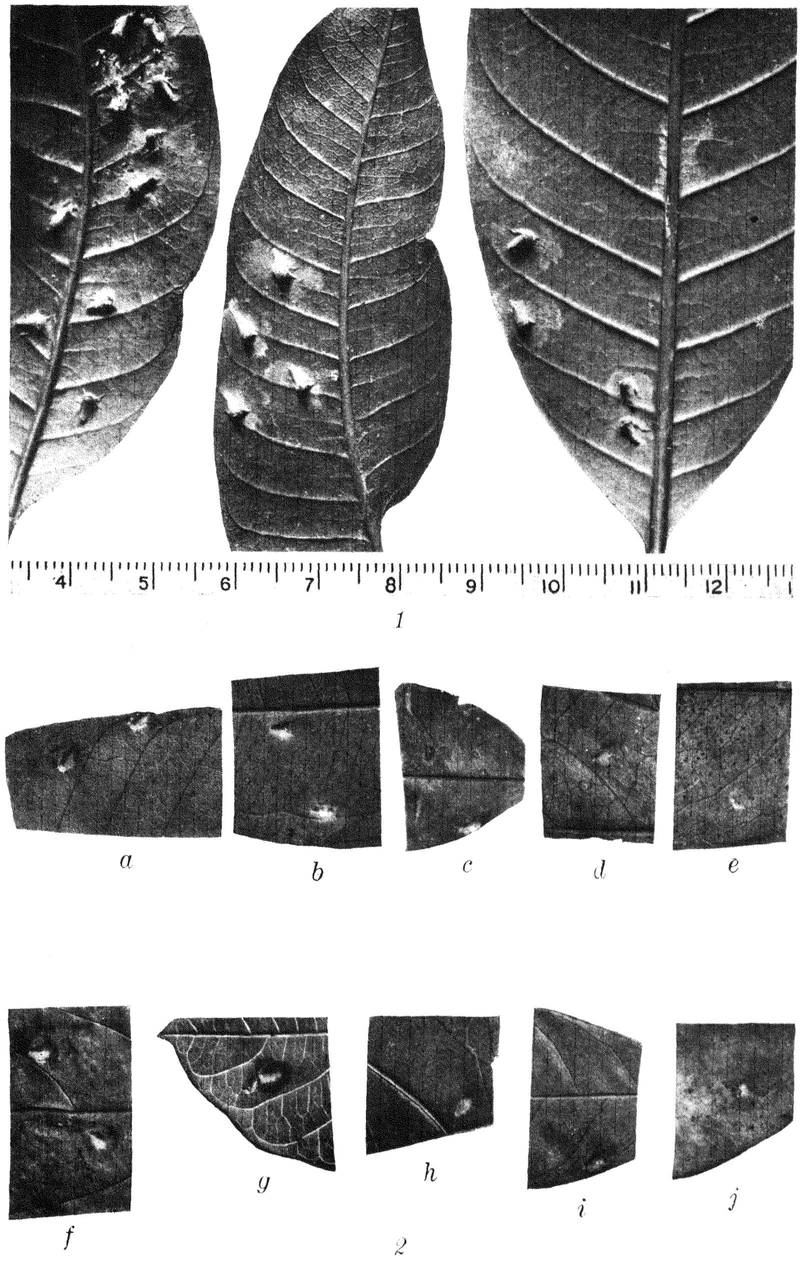

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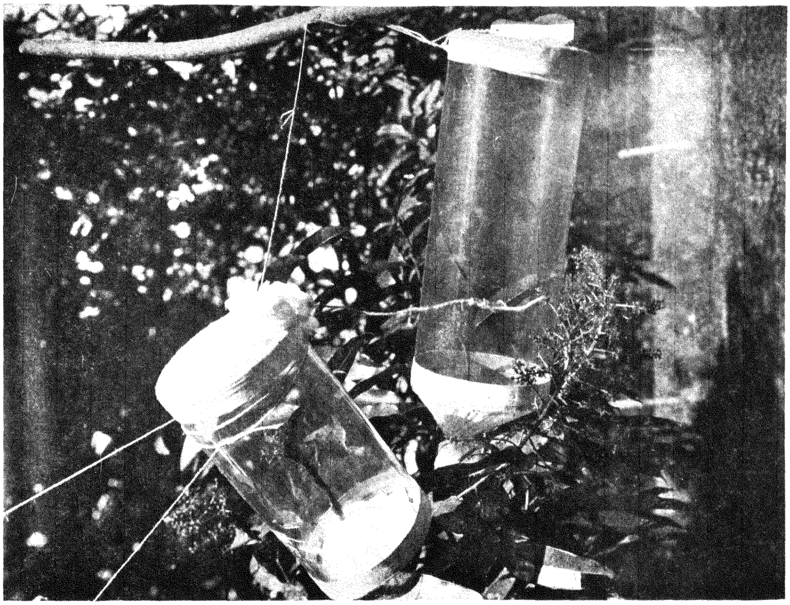
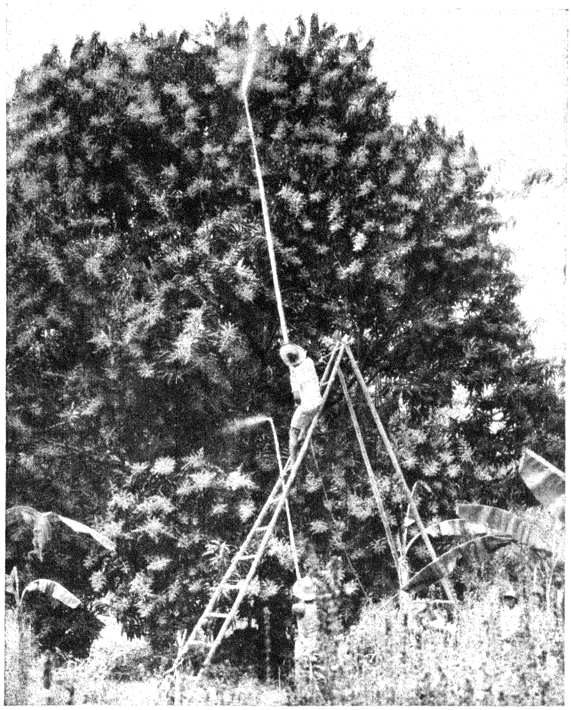


1

a *b* *c* *d*

2

PLATE 9.



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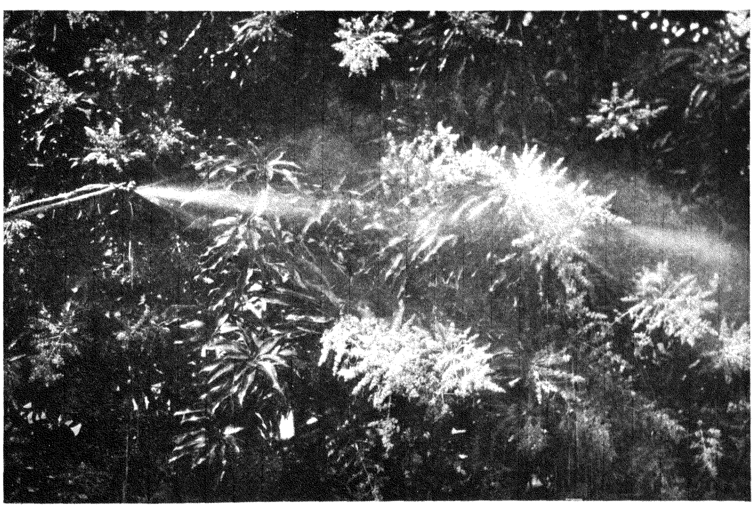

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PLATE 10.

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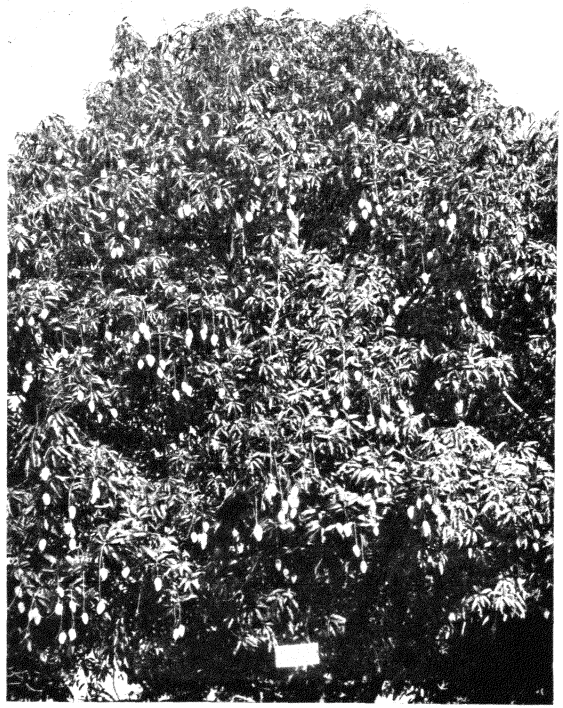

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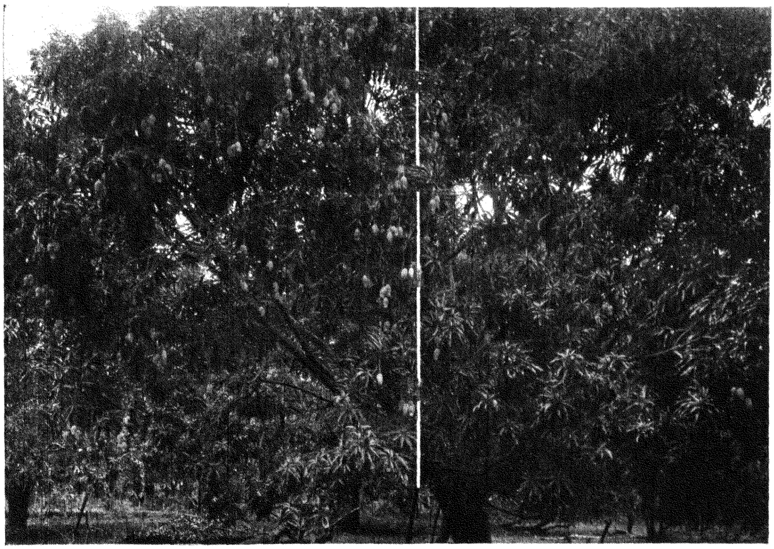

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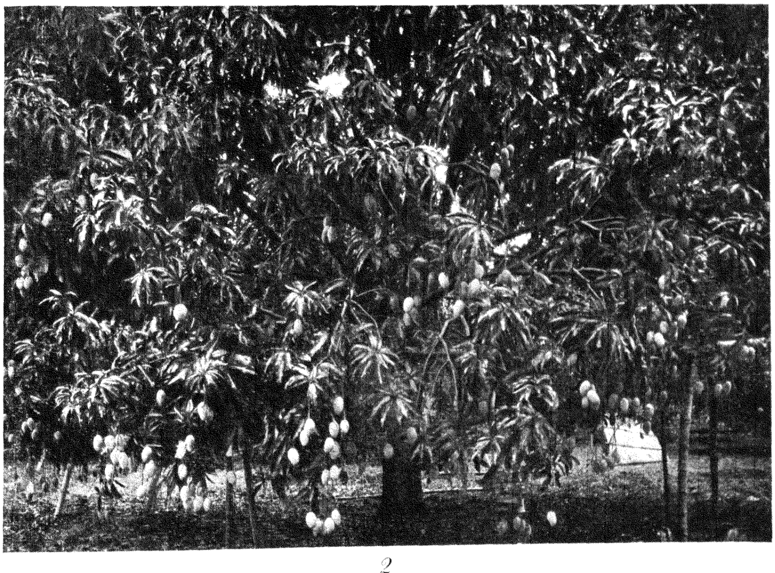

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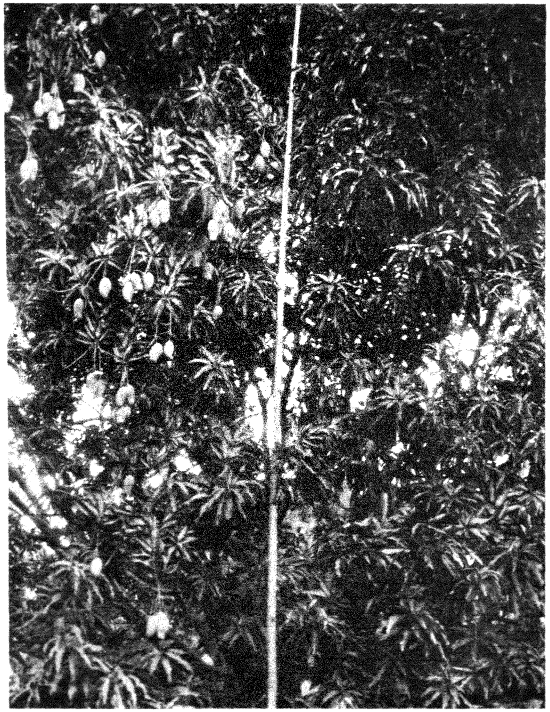
PLATE 12.



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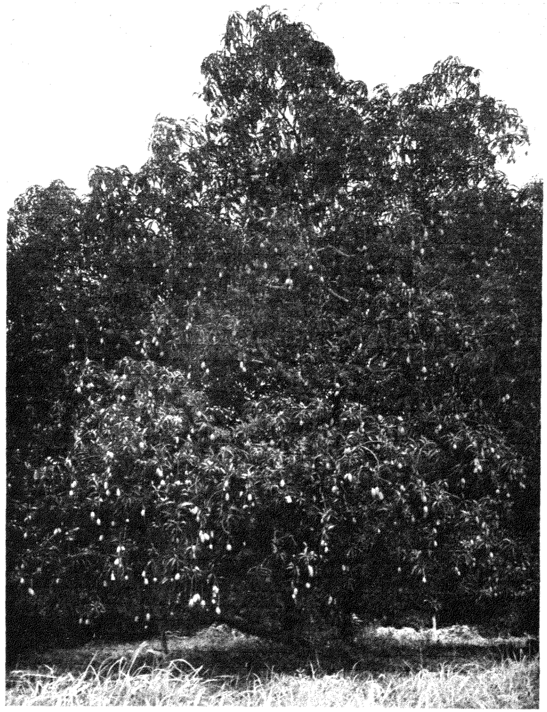

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PLATE 13.

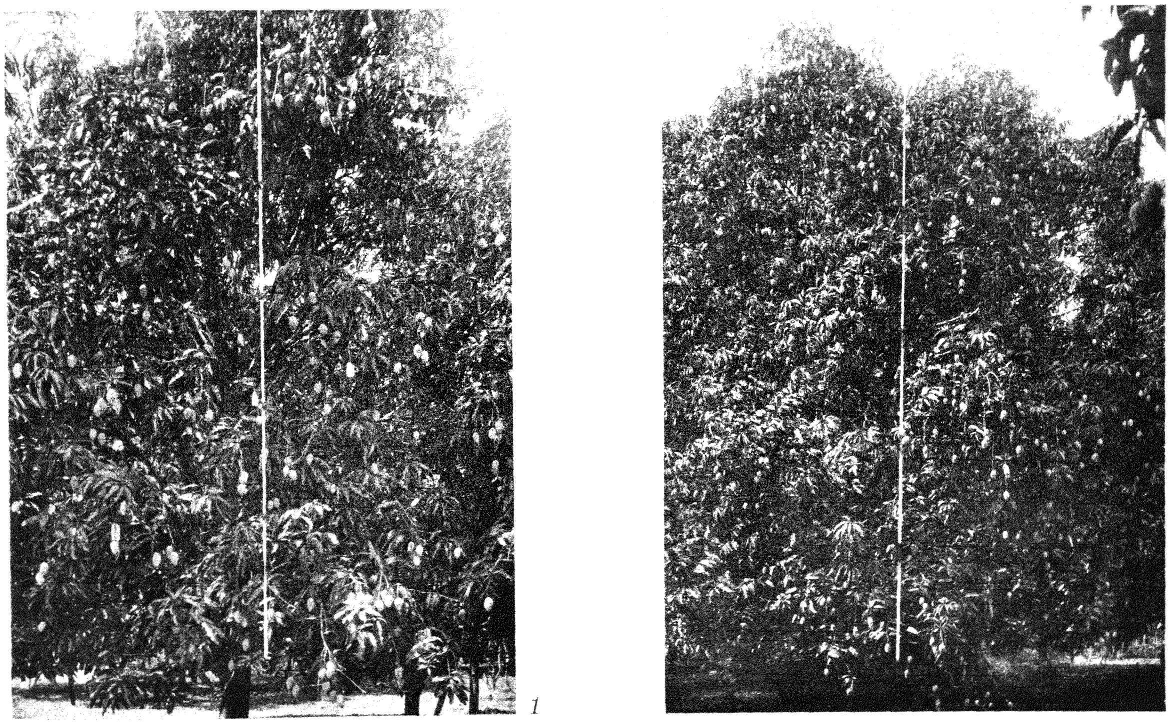

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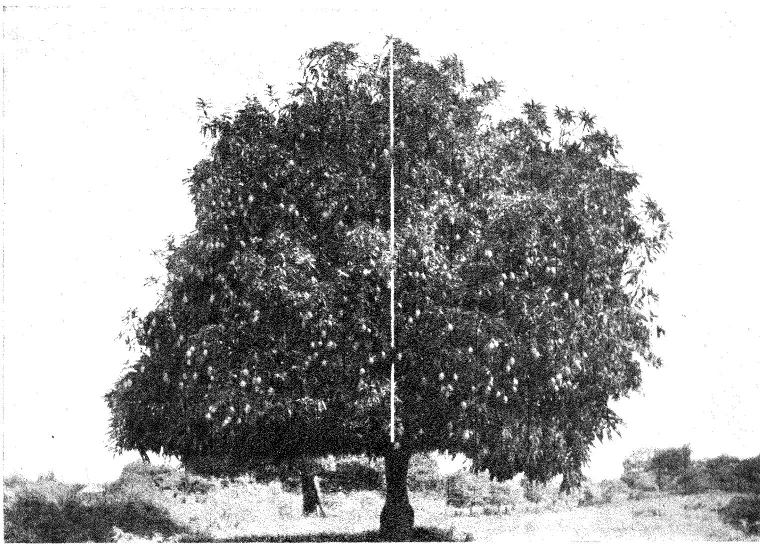
PLATE 14.



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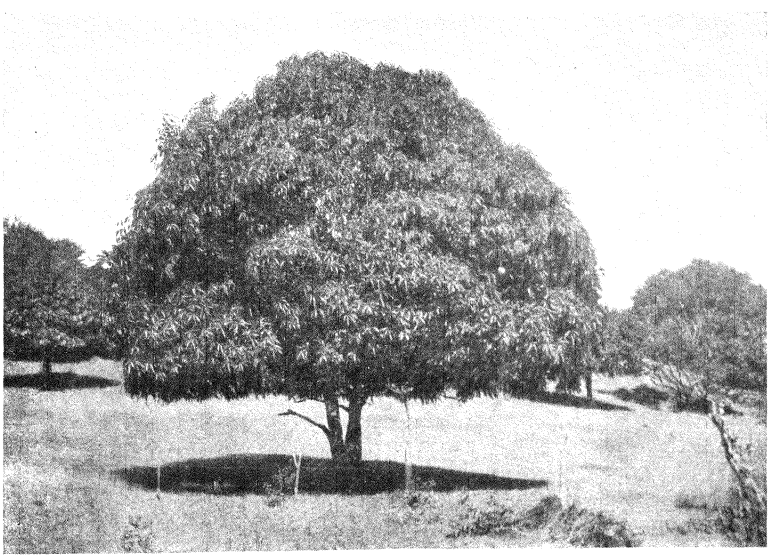

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PLATE 15.


1


2

PLATE 16.

1 2

PLATE 17.

SOLAR ULTRAVIOLET RADIOMETRY *

II, INSTRUMENTS AND METHODS

By Wm. D. Fleming

Major, Medical Corps, United States Army
Member, United States Army Medical Department
Research Board, Bureau of Science, Manila

ONE PLATE AND FIVE TEXT FIGURES

The problem with which these reports deal is the determination of the energy present in the ultraviolet region of sunlight. An attempt has been made to determine this energy in terms of absolute units—watts per square millimeter—for several contiguous spectral regions in the ultraviolet and short-wave-length visible light of sunlight.

The question of the effect of sunlight on man is one demanding much attention of late. Not the least important phase of this question—and certainly not the least vexing—is the matter of the effect of tropical sunlight on the white race. The military bearing of this question on such problems as the length of the tour of duty in the tropical stations of the Army and Navy is obvious. Heretofore the evidence examined as bearing on this matter has been very largely subjective in nature. The present investigation is an attempt to obtain strictly objective evidence.

In this attempt to obtain objective evidence expressed in physical units, one goal sought was the ability to compare such figures with those now being obtained in other parts of the world. This has not been the case with the majority of the work done in the past on sunlight, using biological or photochemical methods. This aspect will be discussed in more detail later.

More specifically, the goal sought is the determination of the energy in four spectral bands of sunlight; namely, 290 to 310 millimicrons, 310 to 370 millimicrons, 370 to 400 millimicrons, 400 to 460 millimicrons, and the total energy in the sunlight be-

* Submitted for publication July 25, 1932.

tween the limits of 290 millimicrons in the ultraviolet and 1,400 millimicrons in the infrared. This limit in the infrared rather than the extreme solar limit was made necessary by certain transmission characteristics of the filter used. These results have been obtained in two forms; namely, in terms of the percentage of the total solar energy present between 290 and 1,400 millimicrons and in terms of microwatts per square millimeter of surface normal to the incident solar light.

METHODS USED

In the past, two methods of estimating the solar energy have been largely used by biological workers; namely, the effect of the light on animals and photochemical reactions.

Methods using animals have never been quantitatively calibrated in even approximate energy terms. Hence it is impossible to make more than the roughest and most general comparison between the results of any two workers, situated in different regions and using different animals. Even if the same species of animal were used, strain and breed variations are so great as to render quantitative comparison of data impossible.

Various photochemical reactions have been used, such as the decomposition of oxalic acid in a solution of uranyl sulphate, (1, 2, 5, 6) the change of lithopone (zinc sulphide), (3) and the fading of an acetone-methylene blue solution. (4) None of these has been more than very roughly standardized in terms of energy units. Unless all conditions can be exactly duplicated, the reporting of radiant energy in terms of milligrams of oxalic acid decomposed does not convey a great deal of information to the physicist even for purposes of comparison. Two further disadvantages would appear to lie in the selectivity of the reactions with respect to wave length and in the possibility of a considerable temperature coefficient.

The temperature coefficient of the oxalic acid-uranyl sulphate reaction is stated to be 1.035 per 10° by Anderson and Robinson. (2) The temperature coefficient of the fading of the methylene blue-acetone solution appears to be too great to neglect. (4)

The selectivity of these photochemical reactions is far from being all that could be desired. The fading of the methylene blue-acetone solution is effected to a perceptible degree by visible light. The spectral selectivity of the lithopone reaction is

narrower—240 to 360 millimicrons—with a maximum at 310 millimicrons. The oxalic acid-uranyl sulphate reaction seems to be activated in some degree by all wave lengths of ultraviolet.(2) If used as a measure of the total ultraviolet energy to which the particular reaction is sensitive, this selectivity is, of course, an advantage, but too often the total reaction has been used as a measure of a narrower band of energy. The photochemical reactions present the advantage of being integrating in effect, hence can be used to express the summation of energy over a given time and offer the further advantage of requiring a minimum of apparatus and attention.

Photographic methods were not considered suitable to the present problem due to difficulties in calibration of the reaction in energy terms.

The photoelectric cell presents much the same situation as regards selectivity to wave length as the photochemical reactions. The range and peak of this selectivity varies with the metal used in the cell. The calibration of the photoelectric cell in terms of energy units is not entirely satisfactory, the cell showing fatigue with age and requiring frequent recalibration.

Many of the circuits for the use of the photoelectric cell depend upon the rate of charge or discharge of a condenser.(9) The very high humidity of the Tropics would in all probability seriously affect such circuits by causing uncontrollable leakage across the condenser terminals and elsewhere. The chances of this occurring will be readily accepted by those who have heard a respectable States's radio degenerate into a spitting, howling instrument of auditory fiendishness after a short exposure to Manila's climate.

In contrast with these selective detectors of radiation the thermopile and bolometer are practically nonselective over the entire wave-length range from the extreme ultraviolet to the very long infrared. Both depend on the heating of a nonselective black surface by the radiation, this heating being measured in the case of the thermopile by the thermoelectric effect, in the case of the bolometer by the change in resistance of the metal heated. In simplicity and ease of manipulation, the thermopile offers many advantages over the bolometer.

The calibration of the thermopile in energy units is fairly simple and stable. For these reasons the thermopile was chosen as the basis of the present work.

GENERAL DESCRIPTION OF METHOD

The most obvious manner in which to employ the thermopile to measure the radiant energy in any spectral region is to expose the thermopile to this radiation and note the deflection of the galvanometer connected to the thermopile. An appropriate filter is then placed over the thermopile and the galvanometer deflection again noted. The difference in the two deflections is, of course, a measure of the energy stopped by the filter. This method necessitates, however, two separate operations between which the intensity of solar radiation may change. Since, as will be shown later, the filter factor of the filter used must be obtained, four separate exposures would be needed. If, however, two thermopiles are connected to a galvanometer, opposing each other, and adjusted to give equal E. M. F. for equal incident radiation, the galvanometer will show no deflection until one of these two thermopiles is covered by a filter, and the deflection then obtained will be a measure of the radiation cut off by the filter. Furthermore, this measure of radiation will be obtained by a single exposure, or if the filter factor must be obtained, the complete measure can be had in two operations rather than four.

In an extension of this principle, Stockbarger(7) has designed a potentiometer circuit in which the galvanometer is used as a null or balance indicator and the percentage of energy passed (or cut off) by the filter is read directly off the potentiometer scale. This is in principle the method used in this work. Two nonselective thermopiles were connected in opposition to a galvanometer through a potentiometer. Four different filters were interposed in turn over one of the thermopiles and the percentage of the solar energy cut off by each filter read off the potentiometer. Finally one thermopile was connected directly to the galvanometer and the deflection produced by total radiation read. The thermopile galvanometer circuit having been previously calibrated in terms of energy units (microwatts per square millimeter), the total energy of the solar radiation could be calculated. By the term "total solar energy" is meant, in this report, the energy passed by a 10-mm stratum of water, including wave lengths 290 to 1,400 millimicrons. The use of this water filter is necessary due to the irregular long-wave cut offs of the glass filters used. The water filter cuts off quite sharply at 1,400 millimicrons.

DETAILS OF INSTRUMENTS

THERMOPILES

The thermopiles were of the general plan of construction of those made by Coblentz.(8) Constantan-copper couples were used, formed from No. 36 Ideal and No. 40 copper wire. A 7-mm length of Ideal wire was cut and the copper wire was soft soldered to each end of this. Targets of silver foil, 0.025 mm thick and 2.5 mm square, were soldered to the junction at the same time, care being taken to secure a butt-to-butt joint of the wires, to have this joint at the center of the target, and to use a minimal amount of solder. It was found less trouble to join the wires and target at the same operation rather than first to join the wires and then attach the targets as has been done heretofore, and it is thought less solder is used. After thorough cleaning from flux the targets and wires were painted with very thin bakelite varnish instead of shellac. The couples were then assembled on a bakelite frame, being held in place with de Khotinsky cement and connected in series with soft solder. The front surface of the "hot" tagets and both surfaces of the "cold" targets were then painted with the usual suspension of lampblack in shellac and the front surface of both "hot" and "cold targets smoked. The completed thermopiles were mounted in a cylindrical case of bakelite, 6 cm in diameter and 9 cm deep, with the target surface 1.5 cm above the bottom of the case. Two slits cut from aluminum were mounted above the targets, the first 1.5 cm above the target, the second 1.5 cm above the first. Each slit was cut to give a 1-mm clearance on all sides of the target surface and was made with beveled edges. The angle subtended on the target by the upper split was about 8 degrees. The case was closed with a bakelite cover which mounted a crystal-quartz window, made of a plano-convex spectacle lens of about 2 diopters focus.

This case was then placed in a similar larger bakelite case with a clearance on sides and bottom of about 6 mm. The cover of the inner case fitted snugly into the outer case, giving an air space of about 6 mm on the bottom and sides of the inner case.

As finally constructed one thermopile (TP_1) consisted of 13 double junctions with a total net target surface of 2.5×29 mm $= 72.5$ sq. mm. The other (TP_2) consisted of 11 double junctions with a total net target surface of 2.5×24 mm $= 60$ sq.

mm. The resistance of TP_1 (13 targets) was 4.8 ohms, of TP_2 (11 targets), 3.6 ohms.

The two thermopiles, each in its double-wall case, were then mounted side by side in a wooden box, large enough to provide at least a 1-inch air space on all sides of each case. The top of this case was provided with means to carry a quartz water cell immediately above each thermopile, and above these water cells trays were fitted to hold either a single or double filter above each thermopile. The box was finally provided with a double-walled top of sheet aluminum. In this there were two rectangular holes with beveled edges, properly spaced to fall over each thermopile, and a shutter was constructed whereby both holes could be closed or opened simultaneously. The box was provided with a second bottom hinged along one side to the box. This bottom had a screw socket for attachment to a heavy tripod. By this means the box could be inclined and rotated so as to allow direct sunlight to fall upon the thermopile targets. The inclination was maintained by two pivoted arms fixed by thumb screws. Along one corner of the box was fastened a small brass tube bearing at the lower end a small piece of brass soldered at an angle of 45° to the axis of the tube. The upper end had two crosswires inserted. When the tube was pointed at the sun the shadow of these crosswires fell on the small reflector at the other end, which was painted white with a small black spot in the center. The tube was so attached to the box that when the sun fell directly on the thermopile targets the crosswire shadow fell on this black spot. Thus, the orientation of the thermopiles on the sun was maintained.

RADIATION POTENTIOMETER

The basic circuit for the radiation potentiometer is shown in fig. 1. This is the figure given by Stockbarger in the article already cited.(7) T_1 and T_2 are the two thermopiles, R_1 is the resistance used to adjust the E. M. F. of T_1 when both thermopiles are exposed to equal radiation so that there is no deflection in the galvanometer, G. For this condition the sliding contact S is at the extreme right end of R_2 and R_3, the two slide-wire resistances.

If a filter is placed over T_2 the E. M. F. of this thermopile will be lowered in proportion to the amount of radiation stopped by the filter, the balance of the two E. M. F.'s will be disturbed and the galvanometer show a deflection. If now S be moved

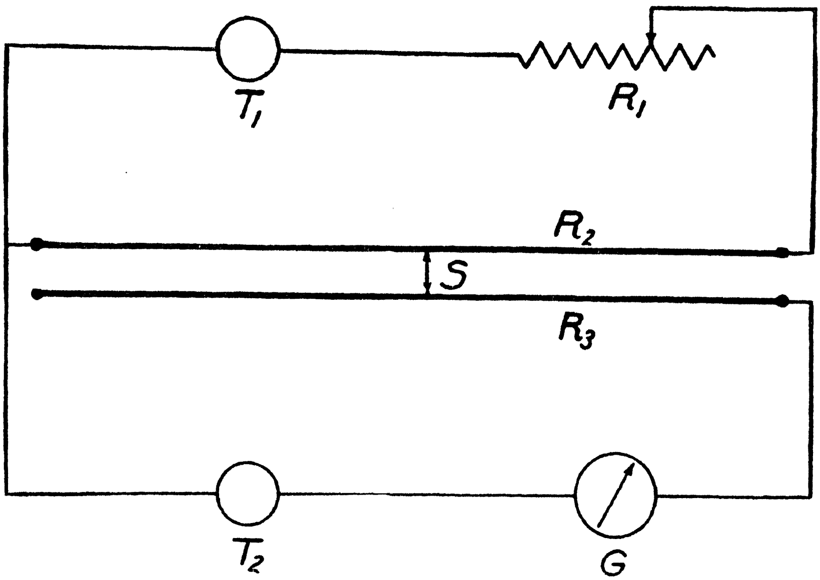

FIG. 1. Basic circuit of radiation potentiometer. (From Stockbarger.)

to the left, the E. M. F. applied from T_1 to the galvanometer will be decreased and a balance again be obtained. If R_2 be graduated in 100 parts the position of S will at once give the percentage of the E. M. F. of T_1 necessary to balance the E. M. F. of T_2 with the filter, which will be equal to the percentage of radiation passed by the filter on T_2.

R_3 enables the damping resistance of the galvanometer circuit to be kept constant whatever the position of S.

The circuit actually used for the potentiometer is shown in fig. 2. In order to keep the instrument in a portable form, the slide wires R_2 and R_3 of fig. 1 were divided into ten sections each, one section of each being formed as the slide wire with movable contact, the other nine sections of each wire being formed by the tapped resistance coils and switches shown. The right-hand resistance coil serves as the nine-tenths of R_3, while the other two coils serve similarly for R_2. The only other important modification of the original circuit is the switch in the negative thermopile leads. This serves to cut out TP_1 and connect TP_2 direct to the galvanometer (all resistance switches being on point 9 and slider on 10) with only the one-tenth section of R_3 in the circuit. Calibration of thermopile TP_2 and the galvanometer was made with this circuit included. The shunt shown

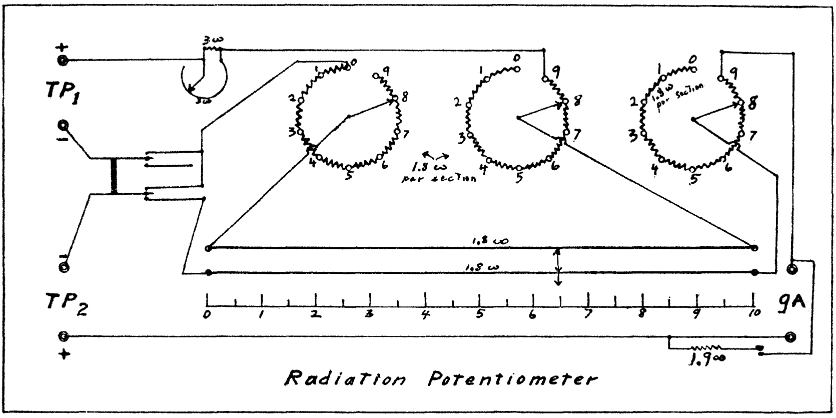

FIG. 2. Radiation potentiometer circuit as used.

across the galvanometer terminals was included to permit a more sensitive galvanometer to be used if necessary, but so far has not been used.

Plate 1 shows the instrument as constructed. It would, of course, be possible to include all three resistance coils under one three-bladed switch, making the instrument somewhat more convenient to use and less liable to error in setting all three switches on the same point. However, such a three-bladed switch was not available in Manila. The resistance coils and slide wires were made of manganin wire, contact points and binding posts of very heavy brass. The three tap switches were of low-resistance contact type from Army Signal Corps radio instruments. The slider was of clock spring. The cut-out switch was of standard telephone type. The instrument was constructed on a 1-inch bakelite panel and housed in a heavy oak box with a large closed air space beneath the panel. The heaviness of construction and the evenness of temperature from hour to hour in the Philippines may account in part for the steadiness of operation of the instrument. At all events very little trouble such as zero shift has been experienced.

GALVANOMETER

The galvanometer used was a suspended-coil portable type made by Leeds and Northrop. The coil and suspension had an overall resistance of 22 ohms. With the reading telescope provided, the sensitivity was 2.7 divisions per microvolt.

While the resistance of the thermopile-potentiometer-galvanometer circuit was not exactly that of the critical damping re-

sistance, the damping was such that satisfactory deflection of the galvanometer was attained in a reasonably short time. Connections from thermopiles to the potentiometer were made of a 45-foot four-conductor cable made of two lengths of double twisted, No. 18 lamp cord tied into a cable with cotton bandage. Connection from potentiometer to galvanometer was made by a 3-foot length of double lamp cord. All connection ends were made of large-size brass spade tips.

If the potentiometer were adjusted for balance and the thermopiles were of the same heat capacity, no deflection of the galvanometer should occur on opening or closing the shutter in front of the thermopiles. However, as made, thermopile TP_1 apparently had a slightly smaller heat capacity than TP_2. This caused a small deflection of the galvanometer to one side when the shutter was opened and another deflection to the opposite side when the shutter was closed. These two deflections returned to the zero position very quickly. The time required for the thermopiles to attain thermal equilibrium appeared to be about the same as the period of the galvanometer coil. Since no assurance could be had of a better match in thermal capacity between other thermopiles that might be made, no attempt was made to improve upon the match of TP_1 and TP_2, since this inequality caused but little delay.

FILTERS

As has been stated, a water cell was used over each thermopile, to secure a uniform long-wave cut off at about 1,400 millimicrons for all filters. These water cells were of fused quartz, 6.5 cm in diameter and 10 mm in internal depth. They were filled with freshly distilled water, hot from the still. This water was changed weekly.

The filters used to cut off the various spectral bands were as follows with the respective wave lengths of zero transmission:

Filter No.	Glass.	Thickness.	Cut off.
		mm.	*Millimicrons.*
30	Window	2.26	310
29	Noviol O	2.54	370
28	Noviol A	2.53	400
27	Noviol C	3.00	460

Three each of these four filters were used. The transmission curves of these filters were determined photographically by a

small Hilger quartz spectrograph by determining the wave length at which the density of the area of the negative made with filter matched the area made without the filter, the exposure through the filter being a known multiple of the exposure without the filter.

When thermopile TP_2 was connected directly to the galvanometer and direct sunlight admitted to the thermopile, the galvanometer deflection was many times full scale. To keep the deflection on the scale, wire screens of copper gauze were used. These were constructed of copper gauze of 100- and 200-mesh soldered to heavy copper frames. The transmission of the screens was determined by means of a standard carbon-filament lamp, thermopile, and galvanometer. The construction and transmission of the four screens used was as follows:

Screen No.	Mesh.	Layers.	Transmission.
22	200	Single	0.215
23	200	Two	0.035
24	100	Single	0.332
25	100	Two	0.109

For ordinary, bright sunlight, screen No. 23 with a transmission of 3.5 per cent kept the galvanometer deflection about one-half to two-thirds full scale.

The so-called "filter factor" of a transmission filter has been defined (10, 11) as the ratio of the energy transmitted by a single filter to the energy transmitted by two superimposed identical filters. The first of these two filters isolates the spectral band to be transmitted by the second filter, and the transmission of this band by the single filter is then measured. The approximate transmission of the filter will then be given by the quotient of the transmission of the single filter divided by this filter factor. The value of the filter factor evidently depends on the spectral energy distribution of the light and since this is the unknown being measured, and presumably varies, the filter factors of each filter must be determined as a preliminary to each analysis. As was stated earlier (first paragraph of description of method), this would necessitate four, or at least three, separate readings being taken of galvanometer deflection, were that method used. With the radiation potentiometer two readings suffice. In the first a single filter is placed over TP_1 and two filters identical with the first are placed over TP_2, the

thermopiles pointed at the light and the potentiometer adjusted to give zero deflection. The reading of the potentiometer then gives the filter factor directly, since its reading is the ratio above mentioned. The filter over TP_1 and one of the filters over TP_2 are then removed and the potentiometer again adjusted to zero deflection.

This second reading of the potentiometer divided by the first reading (filter factor) gives the percentage of energy transmitted by the filter. The determination of the wave-length boundaries of this transmitted energy will be discussed later.

CALIBRATION IN ENERGY UNITS

The calibration of thermopile TP_2 and galvanometer in energy units was made by comparison at a distance of 2 meters with two standard carbon filament lamps obtained from the Bureau of Standards through the courtesy of Dr. W. W. Coblentz. The calibration was made with the potentiometer and connecting leads in circuit. The thermopile had the quartz window in place, but the water cell was not used. The filter factor of the water cell was then determined on several different cloudless days when the sun appeared of constant intensity. The calibration values of the thermopile were divided by this filter factor. Values are given in terms of microwatts per square millimeter. For the circuit consisting of TP_2, galvanometer IC_3, the radiation potentiometer and the 45-foot lead, with no water cell, the calibration value was taken as 1.31 microwatts per square millimeter per centimeter deflection. The filter factor of the water cell was taken as 0.843. Hence, the overall calibration was $\frac{1.31}{0.843} = 1.55$ microwatts per square mm per cm deflection, or

$$\frac{1.55 \text{ watts} \times 10^{-6}}{\frac{\text{mm}^2}{\text{cm}}}.$$

With any but the dullest sun the screens already mentioned were used and the above value divided by the transmission of the screen used. Hence, for the combination most used (screen 23 and the circuit just mentioned) the overall factor would be

$$\frac{\dfrac{1.31 \dfrac{\text{microwatts}}{\text{mm}^2}}{\text{cm}}}{0.843 \times 0.035} = \frac{44.3 \dfrac{\text{microwatts}}{\text{mm}^2}}{\text{cm}}.$$

CALCULATION AND REDUCTION OF DATA

AIR MASS

Air mass was taken as the secant of the zenith angle of the sun, this zenith angle being calculated from the known latitude of the place and the time of observation. This calculation might be made by the fundamental formula

$$\sin h = \sin L \sin d + \cos L \cos d \cos t, \text{ in which}$$

$$\begin{aligned} h &= \text{sun altitude} \\ L &= \text{latitude of place} \\ d &= \text{declination of sun} \\ t &= \text{time of observation,} \end{aligned}$$

but is more conveniently made by the haversine modification

$$\text{hav } z = \text{hav (Co. L} - \text{PD)} + [\text{hav (Co. L} + \text{PD)} - \text{hav (Co. L} - \text{PD)}] \text{ hav } t, \text{ in which}$$

$$\begin{aligned} z &= \text{zenith angle} \\ \text{Co. L} &= \text{colatitude} \\ &= 90° - \text{latitude} \\ \text{PD} &= \text{polar distance} \\ &= 90° - \text{declination} \\ t &= \text{time.} \end{aligned}$$

For the working of this the haversine tables contained in Bowditch's American Practical Navigator(12) and the calculation form shown in fig. 3, which is adopted from Bowditch, will be found convenient.

REDUCTION FACTORS

The greatest difficulty in measurement of radiation by a filter method is due to the fact that no filter we possess has a rectangular cut off. If this could be obtained; that is, if the filter transmitted radiation equally to a certain wave length and the transmission dropped to zero abruptly at this point, the difference in instrument readings with and without the filter would indicate the radiation cut off. But all actual filters have a cut off with a decided slope and this slope is usually sigmoid. In this case, an appreciable amount of energy is cut off by the filter at wave lengths longer than that of zero transmission, and the energy stopped by the filter as represented by the difference in instrument readings includes not only the portion desired but also energy beyond. To cite a specific instance: For filter No. 30 of window glass with zero transmission at 310

Manila

Place Weather Bureau Date 2 Mar 32 Hour 2·10 PM No. 34

		h	m	s			°	′
Local time (120° E)		14	10	—				
			3	54				
LCT		14	13	54	declination	−	7	16
long ±	−	8	3	54	P D (90° − δ)		97	16
GCT		6	10	0	coL (90° − L)		75	25
eq. t	−		12	19	(Manila			
GACT		5	57	41				
long ∓	+	8	3	54	14° 36′ N.			
LACT		14	1	35	120° 58′ 35″ E			
		12	00	00				
t		2	1	35	= 8h 3m 54s)			

	°	′			
coL + PD	172	41	nat hav 0	99593	
coL − PD	21	51	nat hav 0	03592	(subt)
			nat hav A 0	96001	
			log hav A 9	98228	
t 2 h 1 m 35 s			log hav t 8	83711	(add)
			log hav B 8	81939	
			nat hav B 0	06597	
			nat hav (coL-PD) 0	03592	(add)
			nat hav z 0	10189	

z 37° 13′ sec z 1.26 = m

FIG. 3. Form for calculation of air mass.

millimicrons, the spectral region for which this filter was used was 290 to 310 millimicrons. Say the transmission, as obtained by the potentiometer and corrected by the filter factor, was 0.98. The difference of 0.02 between 0.98 and 1.00 is of course the total energy cut off by the filter, but this represents a great deal more than the energy actually present in sunlight between 290 to 310 millimicrons, since to the energy in this band is

added that cut off by the filter in the region of the sloping part of its transmission curve up to λ 535 millimicrons. Therefore, factors must be found by which this total excluded energy may be reduced to give the fractional amount actually in the band desired.

The calculation of this reduction factor was made as suggested by Stockbarger, Dingee, and Burns(13) and by Coblentz and Stair.(14, 15) Referring to fig. 4, curve A is the solar spectral energy distribution curve for air mass 0.0, that is, above the atmosphere, compiled from data of the Smithsonian Institution(16) and of Forsyth and Christison.(17) Curve B is curve A multiplied by the transmissions of air for air mass 1.00. These transmission factors were compiled from data of the Smithsonian Institution(18) and Forsyth and Christison.(17) For air mass other than 1.00 the transmission was taken as $T_m = T_o{}^m$ where T_o = transmission for air mass 1.00, m = air mass. Curve C is curve B multiplied by the maximum transmission of the filter. Curve D is curve B multiplied by the transmission factors of the filter for each wave length. The shaded area between curves C and D then represents the total energy cut off from sunlight by the filter. The ratio of the area included between λ 290 millimicrons and λ 310 millimicrons to this total area is the reduction factor sought, being the fraction of the total excluded energy, which is contained in the desired spectral band λ 290 to 310 millimicrons.

The areas were computed by counting small squares on a large-scale graph. This computation was repeated for various air masses and the factors so obtained used to construct a graph, fig. 5. From this graph the reduction factor for any required air mass up to 5.0 may be read. For stations other than at sea level the air mass was reduced to sea-level values by

$$M_{sl} = M \frac{B}{760},$$

B being obtained from the elevation by the equation(19)

$$\text{Elevation in feet} = 52500 \frac{760 - B}{760 + B}.$$

Reduction factors for the other filters used were obtained similarly to give the energy in the desired spectral bands.

PROCEDURE

The procedure of a determination for any one spectral band has been given in the discussion of filter factor above. In

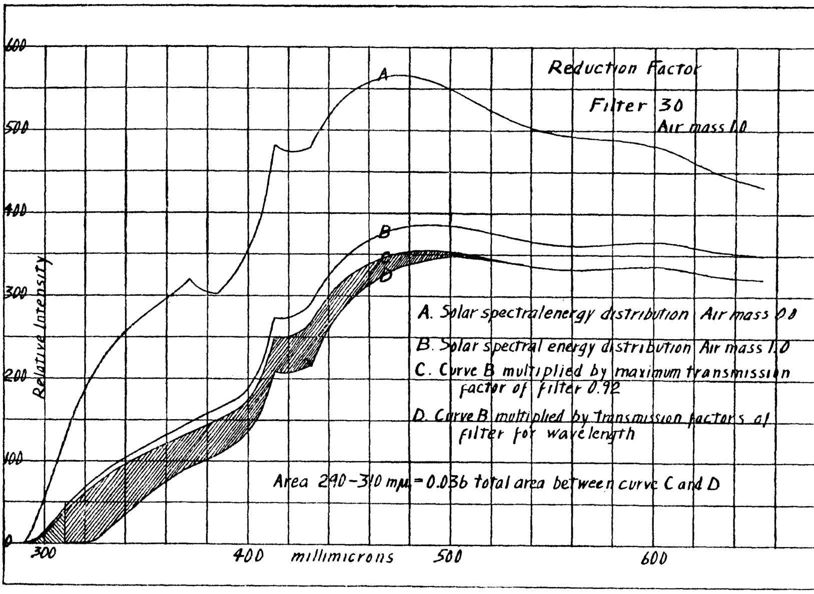

Fig. 4. Graphic calculation of reduction factor for filter 30.

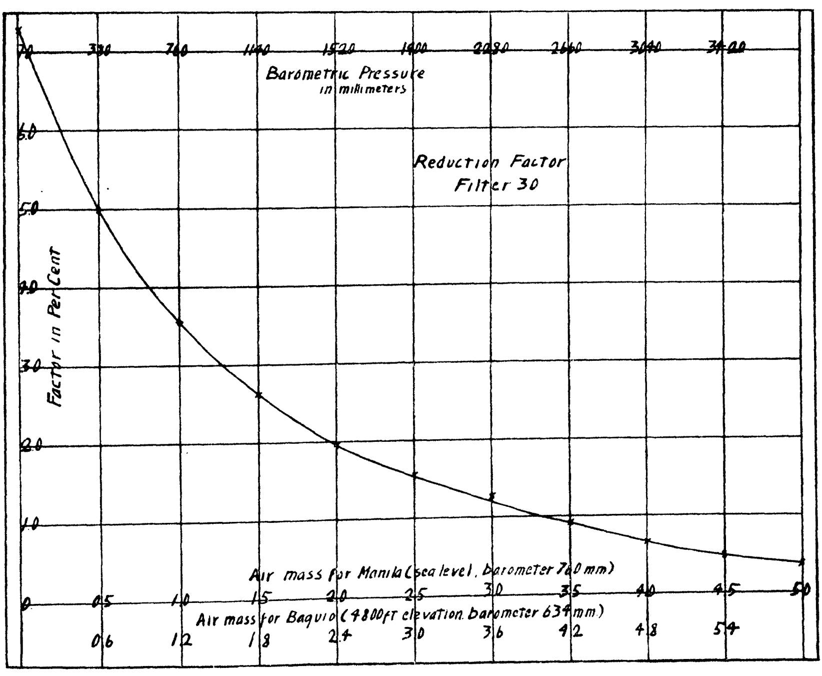

Fig. 5. Reduction factor for filter 30 for varying air mass.

actual use the thermopile box on its tripod was placed to command an unbroken view of the sun. The potentiometer and galvanometer were placed under a shelter affording shade and freedom from air currents across the potentiometer panel or galvanometer. The two stations were connected by the 45-foot connector. The potentiometer and thermopiles were adjusted to balance, and the transmissions of the four filters were determined in succession as rapidly as possible. The switch was then thrown to connect TP_2 direct to the galvanometer and the total energy was determined. The switch was then thrown back for potentiometer connection and the balance without filters tested. If this was not satisfactory the run was rejected. Time of run was taken as being that when the shutter was thrown open for the third filter readings, experience showing this to be the nearest to midpoint of a run. A complete run of the four bands and total energy usually took between seven and ten minutes. With clear sky runs were made every thirty minutes, with cloudy sky runs were made as often as clear sun appeared for a sufficient time. Runs interrupted by clouds were rejected.

The percentage transmission obtained for each of the four filters subtracted from 100 per cent gave the percentage of the solar energy between λ 290 and 1,400 millimicrons cut off by each filter. Each of these percentages was next multiplied by the reduction factor appropriate to the filter and to the air mass at the time. The four products resulting then gave the percentage of total energy lying respectively between

(*a*) 290–310 millimicrons
(*b*) 290–370 millimicrons
(*c*) 290–400 millimicrons
(*d*) 290–460 millimicrons.

The difference between (*a*) and (*b*) is evidently the percentage of energy in the band (*e*) 310 to 370 millimicrons. Similarly, (*c*) minus (*a*) gives the energy between (*f*) 310 to 400 millimicrons, and (*d*) minus (*a*) gives (*g*) 310 to 460 millimicrons. Then, (*f*) minus (*e*) gives (*h*) 370 to 400 millimicrons, and (*g*) minus (*e*) gives (*i*) 370 to 460 millimicrons. Finally, (*h*) minus (*i*) gives (*j*) 400 to 460 millimicrons. The total energy value found multiplied by these resultant percentages gives the energy in each band in microwatts per square

millimeter. The following specimen calculation of an actual run illustrates this:

Camp John Hay, Baguio, Mountain Province, P. I., January 5, 1932; time, 11.21; air mass, 1.31; total energy, 922.

EXPERIMENTAL DATA.

Filter.	Transmission.	Per cent Cut off.	Reduction factor.	Corrected Per cent cut off.	Band
30	0.980	0.020	0.034	0.00068	(a)
29	0.948	0.052	0.34	0.018	(b)
28	0.894	0.106	0.47	0.050	(c)
27	0.808	0.192	0.72	0.140	(d)

CALCULATED DATA.

Band.	Per cent.	Microwatts per sq. mm.
Total 290–1,400	100.0	922
(a) 290–310	0.068	0.63
(b) 290–370	1.8	16.6
(c) 290–400	5.0	46.0
(d) 290–460	14.0	129
(e) (*b* minus *a*) 310–370	1.7	16.0
(f) (*c* minus *a*) 310–400	4.9	45.4
(g) (*d* minus *a*) 310–460	13.9	128
(h) (*f* minus *e*) 370–400	3.2	29.4
(i) (*g* minus *e*) 370–460	12.2	112
(j) (*i* minus *h*) 400–460	9.0	83

DISCUSSION

With clear sun the sensitivity of the instruments was sufficient to show a difference of 0.1 division on the potentiometer scale equivalent to 0.1 per cent transmission. As has been said, runs were made only with a clear, uninterrupted sun. The energy values for each individual band were obtained from the percentages of the total energy. Several minutes necessarily elapsed between any one percentage and the total determination. Hence this requirement of an uninterrupted sun was essential.

The angle subtended by the upper thermopile slit on the target has been stated to be about 8 degrees. Taking the semidiameter of the sun as being roughly 16 minutes of arc, illumination from an appreciable area of the sky adjacent to the sun of course

reached the target, as well as the direct solar light. With clear sun this indirect sky illumination was regarded as negligible.[1]

With the sun clouded over even lightly this ratio of direct to indirect illumination would vary. This variation was shown by a disturbance in the zero balance of the potentiometer. The actual angle subtended by the slit on the thermopile target differed in the two thermopiles. The facilities available when the thermopiles were made were such that this difference could not be avoided in the "homemade" apparatus. This difference in angle caused a variation in this ratio of direct to indirect light to affect the thermopiles unequally, disturbing the zero balance.

The regularity with which the zero balance of the start of a run was found undisturbed at the end of the run is evidence that determinations with clear sun were not appreciably affected by this angle difference. Slits with closer clearance were tried, but their use necessitated such exact orientation on the sun, if shadows on part of the target were to be avoided, that the time required for a run was lengthened unduly.

Another possible explanation of this difference in zero balance obtained with clear sun and with a clouded sun would of course be that one or both of the two thermopiles was selective in response to radiation. This possibility was tested by exposing the two thermopiles to clear sun with and without identical filters over each thermopile. The zero balance without filters was disturbed but a negligible amount by this procedure using any of the four filters No. 30, 29, 28, and 27 and, in addition, Corex red purple, Corex blue purple, and the purple gelatin component of a Wratten No. 2 safelight. Consequently it is felt that the response of both thermopiles was nonselective and that the assumption was justified that this difference in balance with clear and with overcast sun was due to the difference in the ratio of direct to indirect light on the target.

[1] Galvanometer deflections were obtained with the thermopile pointed first directly at the sun and second at the sky immediately adjacent to the sun. The mean ratio of these two deflections for a series of eleven determinations was 0.0028, with a maximum ratio of 0.0052 and a minimum ratio of 0.0012. These were obtained on a day when the sky was not entirely clear, the sun being overcast with a marked haze. With a completely clear sun even lower ratios would be expected. The values obtained for direct sun are therefore regarded as containing a component of sky light of not more than 0.005 of the total and for most of the values this component is about 0.002.

The limitation of the method to use with cloudless sun is not regarded as being as objectionable as might first appear. The basic question which this work attempts to answer is the partial spectral composition of sunlight. If this must be limited to sunlight unfiltered by clouds, the results obtained will probably be on a better basis for comparison with results obtained on similar sunlight elsewhere in the world than if the problem were complicated by the intrusion of such factors as comparative cloudiness of different regions. The problem is one of solar radiation and not of sunshine as affected by cloudiness.

ACKNOWLEDGMENT

The sincere thanks of the writer are offered to Colonel Henry H. Rutherford, Medical Corps, United States Army, Colonel Kent Nelson, Medical Corps, United States Army and Major Rufus L. Holt, Medical Corps, United States Army, for their official support and personal encouragement of this work. Sergeant Loyd Stevens, Medical Department, United States Army, rendered valuable assistance in the construction and calibration of the instruments. The writer's thanks are due Dr. W. W. Coblentz, of the United States Bureau of Standards for helpful criticism and for furnishing the standard lamps used for calibration. The aid rendered by the Rev. Miguel Selga, S. J., director of the Philippine Weather Bureau, both by advice and criticism and by permitting the use of the Manila Observatory for observation on Manila sun, is gratefully acknowledged. Private First Class Gervacio R. Sales, Medical Department, United States Army (Philippine Scouts), rendered most valuable assistance in making the actual observations on the sun. The writer is especially indebted to Mr. Roy Thorson, of Clark and Company, Manila, for his great help in grinding and polishing the quartz used in the thermopile.

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ABSTRACT

Instruments and procedures used in quantitative evaluation of four spectral bands of sunlight are described. These four spectral bands were 290 to 310, 310 to 370, 370 to 400, and 400 to 460 millimicrons. Two thermopiles connected in opposition through a potentiometer circuit to a galvanometer were used. Four glass filters served to cut off increasing amounts of light. The graphical calculation of factors for these filters is described by which the energy excluded in the definite spectral bands desired might be computed. Results obtained in the Philippine Islands and elsewhere will be published in subsequent articles.

ILLUSTRATIONS

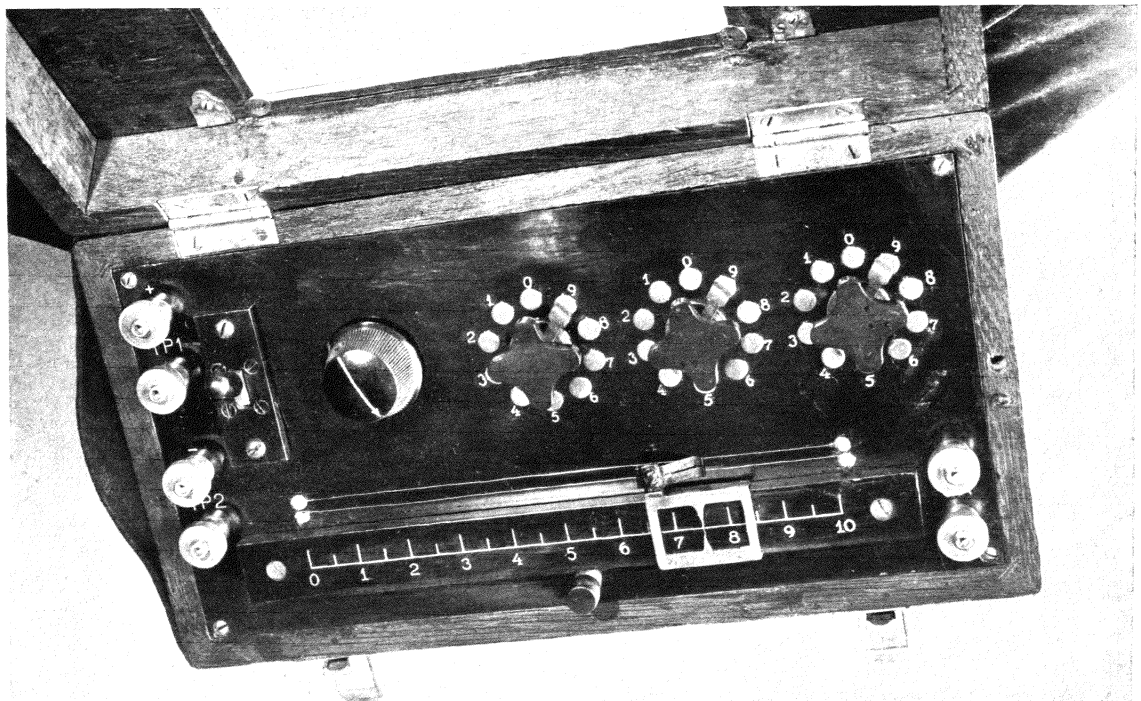

PLATE 1. RADIATION POTENTIOMETER.

ECHINOIDS FROM THE MALUMBANG FORMATION PHILIPPINE ISLANDS

By MERLE C. ISRAELSKY
Of Houston, Texas

FIVE PLATES

Due to the kindness of Dr. R. E. Dickerson, formerly curator of the Department of Palæontology of the California Academy of Sciences, the specimens considered herein were placed at my disposal in the spring of 1923. Various adverse circumstances have prevented earlier completion of the study.

Former Director E. D. Merrill, of the Philippine Bureau of Science, kindly permitted the sending of specimens belonging to that institution.

To Hubert Lyman Clark, I am indebted for several references and a correction in nomenclature.

According to Dr. R. E. Dickerson, the Malumbang formation is lower Pliocene in age.

With the possible exception of *Schizaster pratti* sp. nov., the forms nearest allied to those here figured appear to belong to the living fauna of the western Pacific, which suggests a possibly younger age for the Malumbang formation.

1. CLYPEASTER MALUMBANGENSIS Israelsky, sp. nov. Plate 1, fig. 1.

Test depressed; outline from above roundly pentagonal with margins slightly concave at distal ends of the interambulacra, and slightly convex at distal ends of the ambulacra; margins thin. Within the petalous area the test is moderately arched; flattened from petalous zone to margins. Tubercles numerous, primaries small with sunken areolæ; miliary tubercles very numerous; madreporite circular, ocular and genital pores indistinct in the specimen at hand. Unpaired anterior petal the longest (24.2 mm), paired petals of nearly equal length (about 23.5 mm), all petals broad, short, open at ends. Underside slightly concave from margin to peristome. Periproctal area broken away. Length (estimated), 112 mm; greatest width, 102; height, 12.

Holotype, No. 5216, California Academy of Sciences; plastoholotype, Bureau of Science No. 201; collected by R. E. Dickerson from "Malumbang formation, Philippine Is., Island of Leyte, west coast, 100 meters west of river at San Miguel Barrio, 2 kilometers west of Palompon. Sandstone, dipping NE."

Clypeaster rotundus A. Agassiz,[1] has relatively longer and narrower petals and a thicker margin than the new species. *Clypeaster humilis* Leske [2] is flatter, has longer petals, and is more rounded at the ambitus. The latter species, now living in the East Indian province, is very close to *C. malumbangensis*.

2. CLYPEASTER cf. SCUTIFORMIS Gmelin. Plate 1, figs. 2 to 4.

Laganum multiforme K. Martin var. *tayabum* PRATT and SMITH, Philip. Journ. Sci. § A **8** (1913) pl. 2, fig. 3.

Clypeaster sp. b. DICKERSON, Philip. Journ. Sci. **20** (1922) pl. 13, fig. 4.

The specimen at hand, the same as figured in the above references, is poorly preserved, being but an internal cast. However, it is clearly a *Clypeaster*, and the only apparent difference between it and the specimen figured by A. Agassiz [3] as *Clypeaster scutiformis* Gmelin is that the periproct lies closer to the posterior margin in our specimen. Better preserved material is necessary to determine with certainty whether or not *Clypeaster scutiformis* ranges back into the Malumbang formation.

Length, 48.5 mm; width, 38.2; height, 10.5.

Figured specimen in collection Philippine Bureau of Science, collected by Pratt and Dalburg from "Luzon, Tayabas Province, P. I., Bondoc Peninsula on the hills north of Mount Anuing near the eastern rim of Canquinsa Valley at Bacau. Malumbang Pliocene. 1912."

3. LAGANUM DICKERSONI Israelsky, sp. nov. Plate 2, figs. 1 to 9.

Outline subpentagonal, with margins slightly reëntrant at the interambulacra, length greater than width; greatest width posterior to the extremities to the anterior paired petals; ambitus well rounded, thick. Adoral surface flat, apical system slightly forward of center; madreporite large, roundly pentagonal, with

[1] Clark, H. L., Mem. Mus. Comp. Zoöl. **46** (1914) 38, pl. 128, fig. 6; pls. 132, 133.

[2] Clark, H. L., op. cit. 36, pl. 137; pl. 138, fig. 4.

[3] Illustr. Catal., Mus. Comp. Zoöl. No. 7 (1872–74) pl. 1. 13 f, figs. 1–4.

five genital pores; petals lyre-form, reaching well toward the margins and markedly open at distal extremities. Oral surface flat, slightly concave around mouth with oral grooves slightly sunken and reaching about two-thirds the distance toward margin; periproct round or ovate, lying midway between peristome and posterior extremity.

Measurements of Laganum dickersoni sp. nov.

Collection.	No.	Length.	Width.	Height.
		mm.	*mm.*	*mm.*
California, Academy of Sciences, syntype	5205	38.3	36.2	8.2
Bureau of Science, plastosyntype	203			
California Academy of Sciences, syntype	5206	32.1	29.1	57
Bureau of Science, plastosyntype	204			
California Academy of Sciences, syntype	5207	26.7	22.5	5.3
Bureau of Science, plastosyntype	205			

The relative increase in width with the increase in size is noteworthy. *Laganum dickersoni* differs from *Laganum laganum* (Leske)[4] in having more open petals and a relatively smaller peristome and periproct. The open petals seem quite distinctive. The species is named for Dr. R. E. Dickerson, who supplied the specimens herein considered.

Collected by A. Krystofovich from "Philippine Is., northern Luzon, Cagayan, municipality of Peñablanca, Lagum, between the junction of the rivers Pinnacanauan and Nattelag; abundant fauna of pelecypods, gastropods, and echinoids, as well as corals. Aug. 18, 1921."

4. **LAGANUM EQUÆPETALA** Israelsky, sp. nov. Plate 2, figs. 10 to 12.

Outline subcircular, margin swollen, forming a rim; apical system central with four genital pores; petals equal in length (5.6 mm); oral side slightly concave, peristome circular, periproct at inner edge of rim, transversely elliptical, tubercles over whole of test, largest on swollen margin. Length, 19.9 mm; width, 18.3; height, 4.8.

Holotype in collection of Philippine Bureau of Science, collected by Pratt and Dalburg from "Luzon, Tayabas Province, P. I., Bondoc Peninsula, on the hills north of Mount Anuing,

[4] Agassiz, Louis, Mon. Scutelles (1841) 108, pl. 22, figs. 25–27; pl. 23, figs. 8–12. Figured as *Laganum bonani* Klein. H. L. Clark kindly supplied this nomenclatorial correction.

near the eastern rim of Canquinsa at Bacau. Malumbang Pliocene."

This species is distinguished from *Laganum orbiculare* Leske [5] by its equal-lengthed petals, relatively greater height, and thicker margin. *Laganum orbiculare* has been reported by Herklots [6] from the Tertiary of Java, and he justly remarks that his form is closer to the variety *marginale* [7] Agassiz than to typical *orbiculare*.[8] His measurements are "diameter antero-posterior 24‴ transversal 21‴, hauteur du sommet 5.5‴ du bord 2‴." From these it is readily seen that the new species is much more nearly circular in outline than Herklots's specimen.

5. **LAGANUM cf. DECAGONALE** Lesson. Plate 1, fig. 5.

A rather imperfect specimen which seemingly closely resembles *Laganum decagonale* as figured by de Meijere.[9] Length, 35 mm; width, 28.9; height, 5.1.

Plesiotype No. 5200, California Academy of Sciences; platoplesiotype, Bureau of Science No. 206; locality not known.

6. **PERONELLA MERRILLI** Israelsky, sp. nov. Plate 2, figs. 17 to 19.

Clypeaster sp. a DICKERSON, Philip. Journ. Sci. 20 (1922) pl. 13, figs. *3a*, *3b*.

Outline broadly subelliptical, slightly narrowed posteriorly, margin gently inflated, apex low; apical system somewhat forward of center with four genital pores; petals reach over one-half way to margins, nearly equal in length; oral surface but slightly concave; peristome circular, forward of center, furrows obscure, periproct circular and about twice its diameter from the posterior margin. Length, 30.7 mm; width, 26; height, 4.5.

Holotype, No. 5209, California Academy of Sciences; plastoholotype, Bureau of Science No. 207; collected by E. W. McDaniel and Roy E. Dickerson from "Philippine Is. Luzon, Tayabas Province, Bondoc Peninsula, west side Ragay Gulf, two and three fourths kilometers northwest of Bureau of Lands Bench Mark No. 1, in coarse sandstone (coral and shell sand) dipping 12 ° S, strike N. 50 ° W."

[5] De Meijere, Siboga-Expeditie, Echinoidea 43 (1904) 126, pl. 6, figs. 69, 73–75.

[6] Herklots, J. A., in Junghuhn, Fossiles de Java, Echinodermes, pt. 4. Leide (1854).

[7] Agassiz, Louis, Mon. Scutelles (1841) 121, pl. 22, figs. 11–15.

[8] Agassiz, op. cit. 120, pl. 22, figs. 16–20.

[9] De Meijere, Siboga Expeditie, Echinoidea 42 (1904) 11, pl. 6, figs. 58–62.

The new species is much more elongated and less inflated at the margin than is *Laganum orbiculare* Leske.[10] Named for former Director E. D. Merrill, by whose permission the specimens belonging to the Philippine Bureau of Science were made accessible for study.

7. **PERONELLA RAGAYANA** Israelsky, sp. nov. Plate 2, figs. 13 to 16.

Outline of test nearly circular, slightly longer than wide, adoral surface gently concave from margin to apex, apical system slightly forward of center, with four genital pores at the head of the paired ambulacra, petals widely open proximally, reaching over half way to margin from apex, odd anterior slightly longer than the anterior paired petals, but shorter than the posterior pair. Underside slightly concave, peristome round, slightly forward of center, periproct round, about twice its diameter from edge.

Measurements of Peronella ragayana sp. nov.

Collection.	No.	Length.	Width.	Height.
California Academy of Sciences, holotype	5212	[a] 38.0	[a] 34.0	6.6
California Academy of Sciences, paratype	5213	12.0	11.3	2.2
Bureau of Science, plastoholotype	208			

[a] Estimated.

Collected by E. M. McDaniel and Roy E. Dickerson from "Philippine Is., Tayabas Province, Bondoc Peninsula, west side of Ragay Gulf, two and three fourths kilometers northwest of Bureau of Lands Bench Mark No. 1, in coarse sandstone (coral and shell) dipping 2° S. Strike N. 50° W."

The species here described has a marked resemblance adorally to *Peronella pellucida* Doderlein[11] but that species has shorter petals and the periproct is more distant from the margin.

8. **SCHIZASTER PRATTI** Israelsky, sp. nov. Plate 4, figs. 2, 3; Plate 5, figs. 1 to 4.

Schizaster subrhomboidalis Herklots, PRATT and SMITH, Philip. Journ. Sci. § A 8 No. 5 (1913) pl. 2, fig. 5.

Schizaster subrhomboidalis Herklots, DICKERSON, Philip. Journ. Sci. 20 No. 2 (1922) pl. 13, figs. 5*a*, 5*b*. Not *Schizaster subrhomboidalis* Herklots, J. A. HERKLOTS in Junghuhn, Fossiles de Java, Echinodermes, pt. 4. Leide 5 (1859) 20, fig. 4.

Test ovoid, highest in odd posterior interambulacrum and narrowed in the same area; apical system posterior to center (de-

[10] Agassiz, Louis, Mon. Scutelles (1841) 120, pl. 22, figs. 16–20.

[11] Doderlein, Arch. f. Naturg. (1885) 51, Jahrgang, pt. 1, p. 104. H. L. Clark, Mem. Mus. Comp. Zoöl. 46 (1914) 53, pl. 42, figs. 1, 8, 9, 10.

tail obliterated), petals deeply sunken, the odd anterior groove passing under the ambitus to the peristome; anterior paired petals reach half way to ambitus, straight except in immediate proximity to the apical system, posterior petals short, forming an acute angle; posterior interambulacrum ridged; plastron broad; peristome semilunar with strong posterior lip, periproct well up on posterior truncation just below termination of ridge.

Measurements of Schizaster pratti sp. nov.

Collection.	Length.	Width.	Height.
Bureau of Science, cotype A	60.7	57.5	43.2
Bureau of Science, cotype B	51.6	48.5	36.0

Collected by Pratt and Dalburg from "Luzon, Tayabas Province, P. I., Bondoc Peninsula on the hills north of Mount Anuing near the eastern rim of the Canquinsa Valley at Bacau. Malumbang Pliocene. 1912."

This species compares very closely with *Schizaster progoensis* Gerth [12] from the Upper Miocene of Java, but differs from it in that the dorsal slope is much steeper and the apical system is relatively more anterior. Named for Mr. Wallace E. Pratt, in recognition of his geologic work in the Philippines.

9. PERICOSMUS SCHENCKI Israelsky, sp. nov. Plate 3, figs. 1 and 2; Plate 4, fig. 1.

Test large, thick shelled; outline broadly elliptical; apical system forward of center, odd anterior ambulacrum but slightly depressed, the paired ambulacra well sunken, narrow and approximately equal in length, apical system obscure in specimen at hand; peripetalous fasciole enters interradia; traces of marginal fasciole discernible; peristome well forward, periproct transversely elliptical. Actual measurements of the crushed specimen are: Length, 120 mm; breadth, 112; height, 63.

Holotype, No. 5217, California Academy of Sciences plastoholotype, Bureau of Science No. 202; collected by R. E. Dickerson and E. W. McDaniel from "Philippine Is., Luzon, Tayabas Province, Bondoc Peninsula, west side of Ragay Gulf, 2.75 kilometers northwest of Bureau of Lands Bench Mark No. 1, in coarse sandstone (coral and shell sand) dipping 12° S., strike North 50° West."

[12] Gerth, H., in K. Martin, Samm. Geol. Reichs-Mus. Leiden, Neue Folge, Bd. 1, 2te Abt., Heft 4 (1922).

The large size of the species is noteworthy. The peripetalous fasciole in *Pericosmus macronesius* Koehler[13] is much more angulated than in this species. This species is named for Dr. H. G. Schenck, in recognition of his work on Philippine geology.

10. SPATANGID sp. indeterminate, A.

Schizaster subrhomboidalis PRATT and SMITH, Philip. Journ. Sci. § A 8 (1913) pl. 3, fig. 4. Not *Schizaster subrhomboidalis* HERKLOTS, in Junghuhn, Fossiles de Java, Echinodermes, pt. 4. Leide 5 (1859) 20, fig. 4.

Figured specimen in collection of the Philippine Bureau of Science. Collected by Eveland and Smith from "Limestone ridge 2 kilometers west of the city hall and north of the Weather Observatory, Baguio. This is the upper limestone in the Benguet district."

11. SPATANGID sp. indeterminate, B.

Schizaster subrhomboidalis SMITH, Philip. Journ. Sci. § A 8 (1913) 291, pl. 19, fig. 1. Not *Schizaster subrhomboidalis* Herklots, J. A. HERKLOTS, in Junghuhn, Fossiles de Java, Echinodermes, pt. 4. Leide 5 (1859) 20, fig. 4.

Figured specimen in collection of the Philippine Bureau of Science. Collected by W. D. Smith from "Minanga River, white cliffs near camp 1, Cebu Province in limestone rubble."

[13] Koehler, Echinoderma of the Indian Museum, pt. 8, Echinoidea (1), Calcutta (March, 1914) 133, pl. 12, figs. 1–5.

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ILLUSTRATIONS

PLATE 1

[Figures natural size.]

FIG. 1. *Clypeaster malumbangensis* Israelsky, sp. nov., holotype, No. 5216, California Academy of Sciences type collection; adoral view.

2. *Clypeaster* cf. *scutiformis* Gmelin; figured specimen, Philippine Bureau of Science collection; adoral view.
3. Same as fig. 2, oral view.
4. Same as fig. 2, side view.
5. *Laganum* cf. *decagonale* Lesson; figured specimen, plesiotype, No. 5208, California Academy of Sciences type collection; adoral view.

PLATE 2

[Figures natural size, except as noted.]

FIG. 1. *Laganum dickersoni* Israelsky, sp. nov., syntype, No. 5205, California Academy of Sciences type collection; adoral view.

2. Same as fig. 1; oral view.
3. Same as fig. 1; side view.
4. *Laganum dickersoni* Israelsky, sp. nov., syntype, No. 5206, California Academy of Sciences type collection; adoral view.
5. Same as fig. 4; oral view.
6. Same as fig. 4; side view.
7. *Laganum dickersoni* Israelsky, sp. nov., syntype, No. 5207, California Academy of Sciences type collection; adoral view.
8. Same as fig. 7; oral view.
9. Same as fig. 7; side view.
10. *Laganum equæpetala* Israelsky, sp. nov., holotype, Philippine Bureau of Science collection; adoral view, × 2.
11. Same as fig. 10; oral view, × 2.
12. Same as fig. 10; side view, × 2.
13. *Peronella ragayana* Israelsky, sp. nov., paratype, No. 5213, California Academy of Sciences type collection; adoral view, × 2.
14. Same as fig. 13; oral view, × 2.
15. *Peronella ragayana* Israelsky, sp. nov., holotype, No. 5212, California Academy of Sciences type collection; adoral view.
16. Same as fig. 15; side view.
17. *Peronella merrilli* Israelsky, sp. nov., type, No. 5209, California Academy of Sciences type collection; adoral view.
18. Same as fig. 17; oral view.
19. Same as fig. 17; side view.

PLATE 3

[Figures natural size.]

FIG. 1. *Pericosmus schencki* Israelsky, sp. nov., holotype, No. 5217, California Academy of Sciences type collection; adoral view.

2. Same as fig. 1; side view.

PLATE 4

[Figures natural size.]

FIG. 1. *Pericosmus schencki* Israelsky, sp. nov., holotype, No. 5217, California Academy of Sciences type collection; oral view.

2. *Schizaster pratti* Israelsky, sp. nov., cotype A, Philippine Bureau of Science collection; adoral view.

3. *Shizaster pratti* Israelsky, sp. nov., cotype B, Philippine Bureau of Science collection; adoral view.

PLATE 5

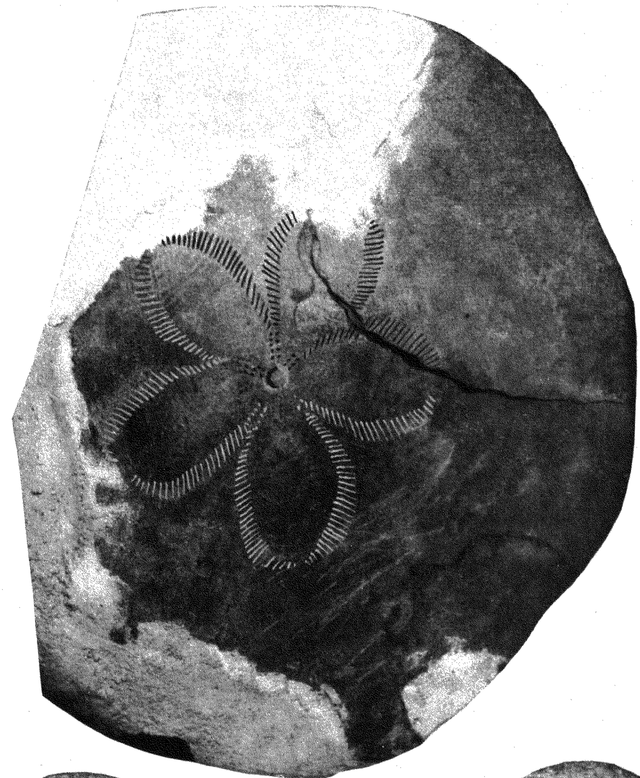
[Figures natural size.]

FIG. 1. *Schizaster pratti* Israelsky, sp. nov., cotype B, Philippine Bureau of Science collection; oral view.

2. Same as fig. 1; side view.

3. Same as fig. 1; rear view.

4. Same as fig. 1; front view.



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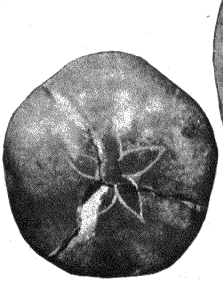

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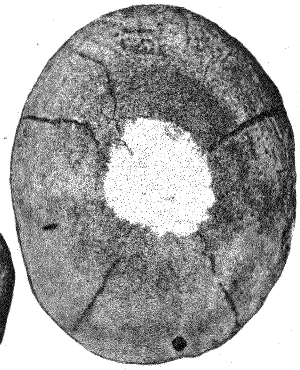

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PLATE 1.

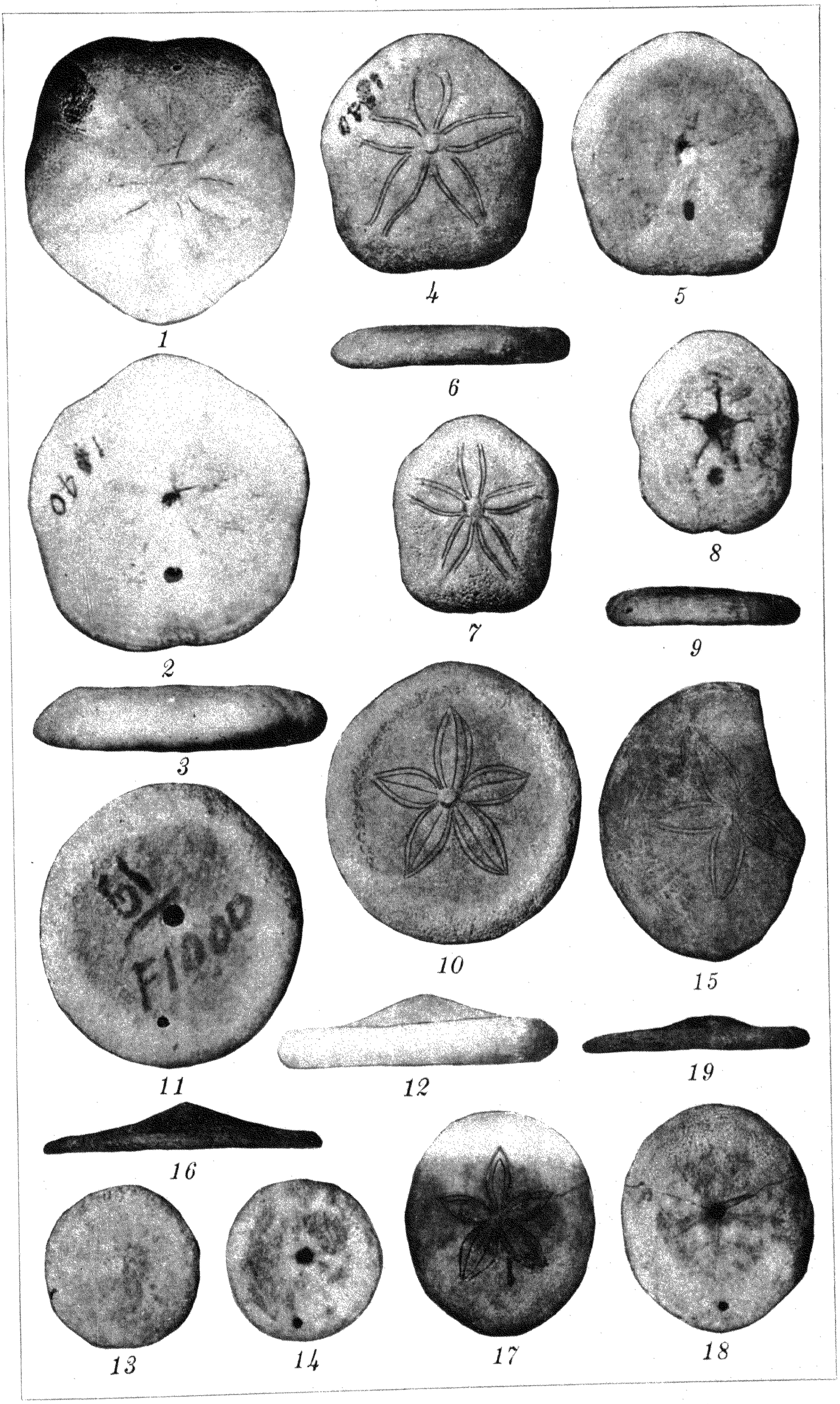
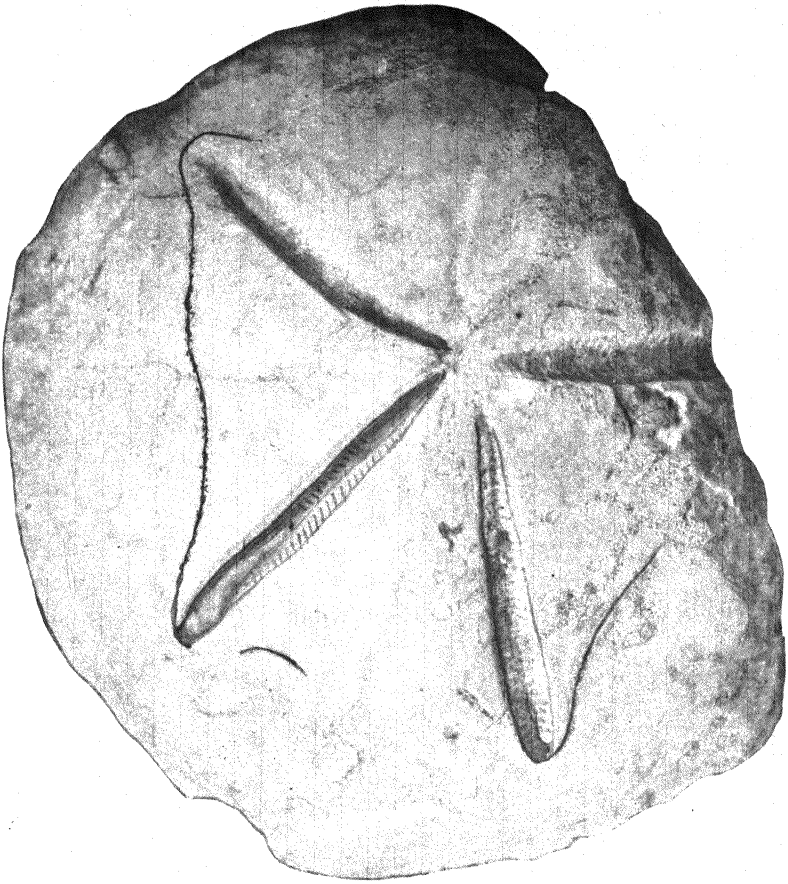


PLATE 2.



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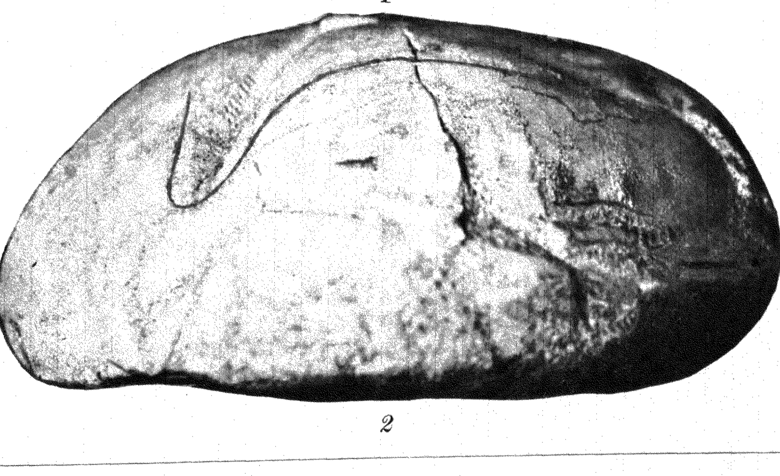

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PLATE 3.

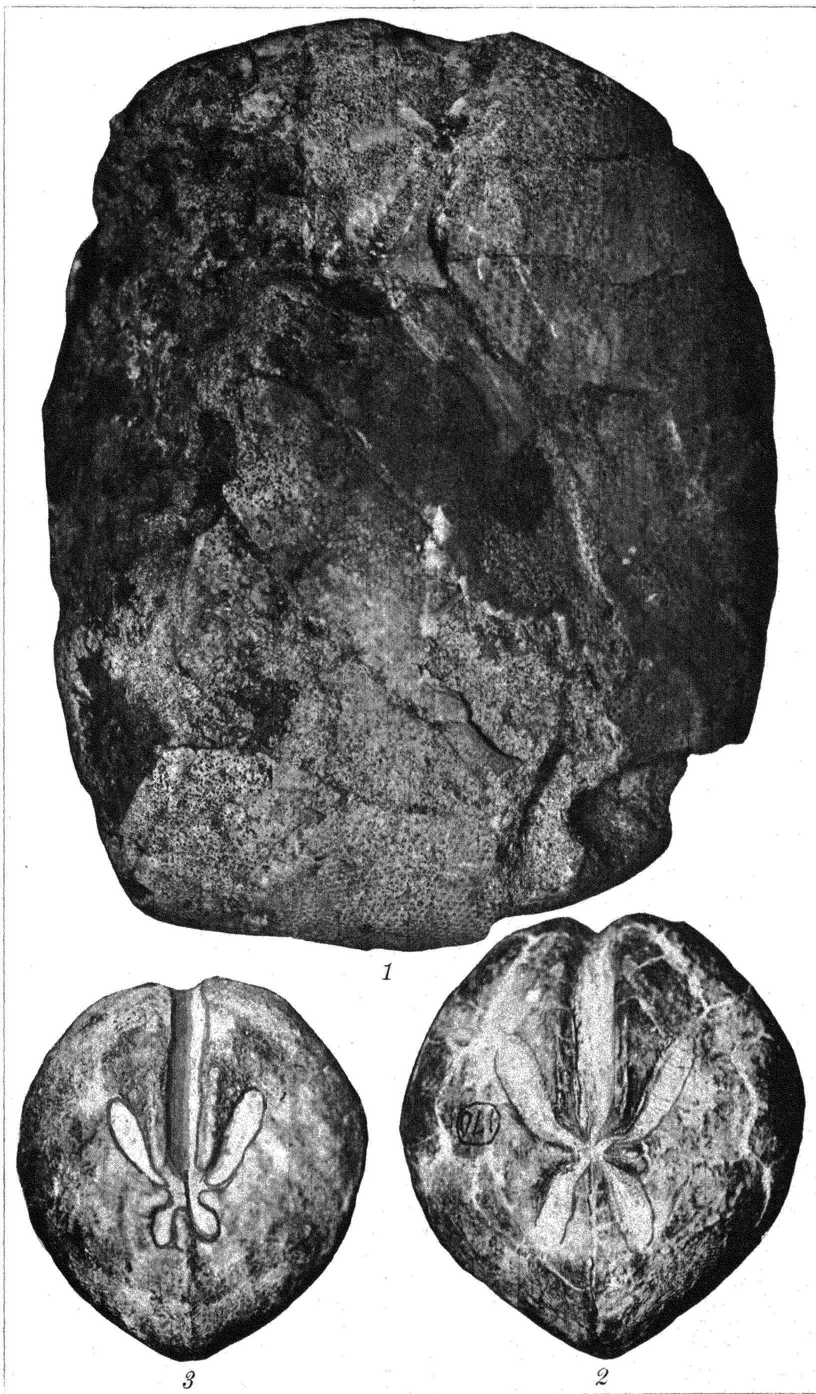

PLATE 4.

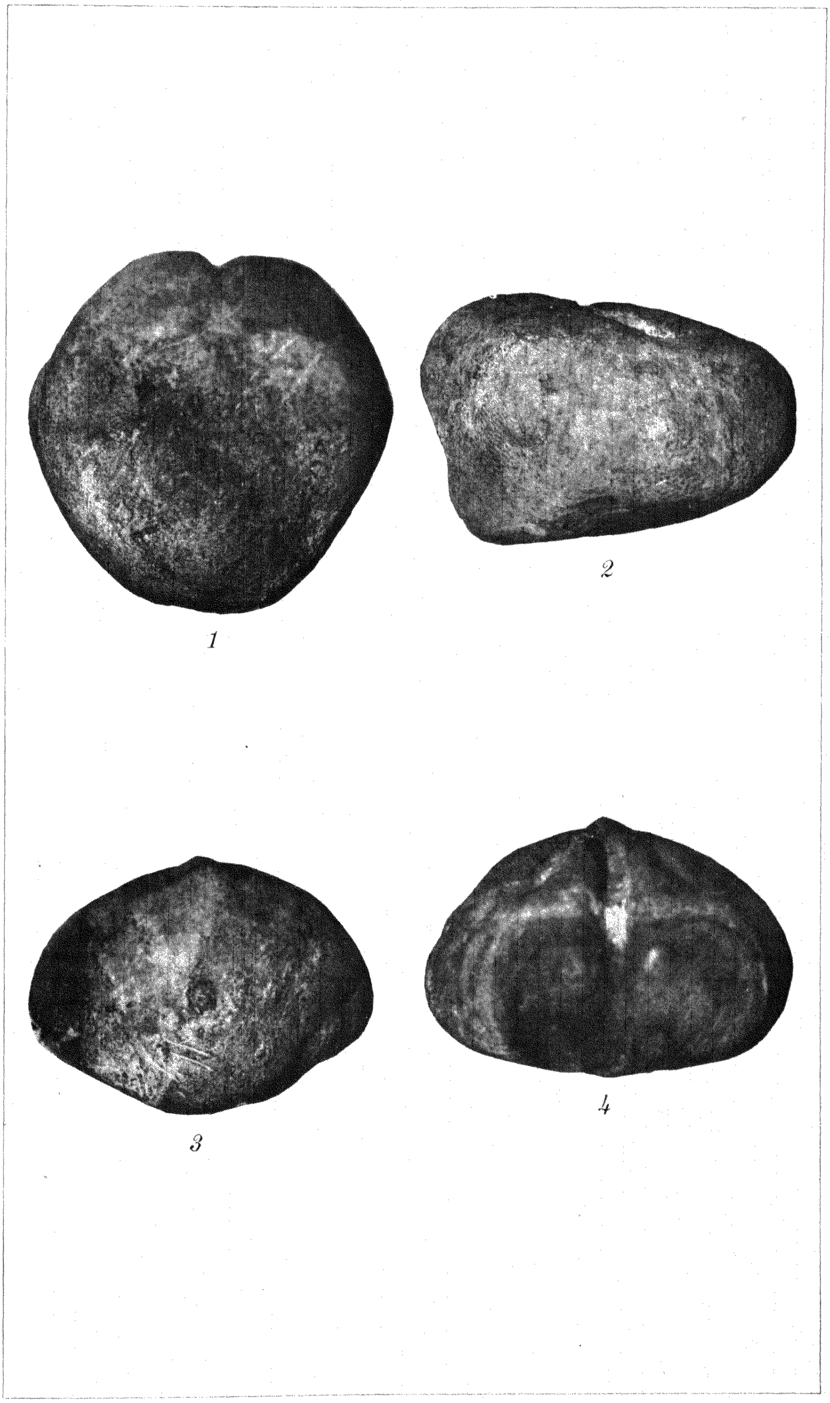

PLATE 5.

DIE HOPLIONOTA-ARTEN VON DEN PHILIPPINEN-INSELN (COLEOPTERA; CHRYSOMELIDÆ)

Von FRANZ SPAETH

Vienna, Austria

EIN TEXT FIGUR

Als ich die Gattung *Hoplionota* vor zwanzig Jahren zum ersten Male zusammenfassend bearbeitete, waren von den Philippinen-Inseln nur 6 Arten bekannt; seitdem hat sich ihre Zahl auf 25 erhöht; dies ist in erster Linie ein Verdienst des leider viel zu früh verstorbenen Ch. F. Baker, des unermüdlichen Erforschers der Fauna dieser Inseln.

Da die erschienenen Einzelbeschreibungen vielleicht die Unterschiede nicht immer leicht erkennen lassen, habe ich hier die Form einer analytischen Tabelle gewählt.

Zur Beschreibung der gerade bei *Hoplionota* besonders wichtigen Skulptur der Flügeldecken habe ich die in der eingangs zitierten Arbeit vorgeschlagenen Bezeichnungen gewählt und füge zu deren besseren Verständnis bei:

Im allgemeinen sind auf jeder Flügeldecke zwei Längsrippen und zwei oder drei Querleisten, ferner eine Anzahl Höcker oder auch Dorne vorhanden, die sich aus dem seinerzeitigen Flügelgeäder und seinen Verästungs-Stellen ableiten lassen.

Die innere Längsrippe nannte ich Dorsalrippe, *D*, die äussere, über die Schulterbeule laufende: Humeralrippe, *H;* letztere ist vorn meist winklig nach aussen gebogen, seltener gegabelt. Von den Querleisten läuft eine nahe hinter oder auch in der Mitte; sie ist die Mittelleiste und zerfällt in den äusseren Teil zwischen dem Scheibenrand und der Dorsalrippe; diesen Teil nannte ich Pontalleiste, *P*, den anderen zwischen Dorsalrippe und Naht: Suturalleiste, *S;* die zweite Querleiste liegt auf dem Abfall, sie heisst Spitzen oder Apikalleiste, *A;* seltener ist hinter ihr noch eine dritte Querleiste: die Postapikalleiste, *PA;* die Apikalleiste, *A*, setzt sich zuweilen über die Dorsalrippe nach innen fort; aussen reicht sie meist bis zu einem kleinen Höcker, an dem sie

sich in mehrere Aeste gabeln kann. Einer dieser Aeste geht nach hinten zum Scheibenrand: es ist die costa terminalis, *Ct*, der zweite gerade oder schräg auswärts: die furca externa, *Fe;* der dritte entweder gerade nach vorn oder mehr nach innen auf den Haupthöcker gerichtet: die furca interna, *Fi;* endlich geht oft ein kleiner Ast noch vor dem Marginalhöcker nach hinten: die costa ultima, *Cu;* häufig ist diese isoliert und bildet einen kleinen Höcker. Von den Höcker oder Dornen stehen normal vier in der Dorsalreihe: der Basalhöcker, *1*, an der Basis, der Postbasal, *2*, hinter ihm, oft sehr klein; die Dorsalreihe ist zwischen diesen beiden Höckern meist niedrig, oft auch ganz unterbrochen; in oder hinter der Mitte folgt der Haupthöcker, *3*, fast immer der höchste und grösste von allen, an der Kreuzungsstelle der Dorsalrippe mit der Mittelleiste. Meist treffen der vordere und der rückwärtige Teil der Dorsalrippe die Mittelleiste in demselben Punkte, so dass sich nur ein gemeinsamer Schnittpunkt ergibt; oft aber trifft der vordere Teil die Mittelleiste weiter aussen (nur bei den Arten aus Neu—Guinea und Australien weiter innen) als der rückwärtige, so dass zwei Schnittpunkte vorliegen.

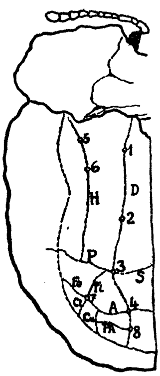

FIG. 1. Skulptur der Flügeldecken der *Hoplionota*.

Der vierte Höcker der Dorsalreihe ist der Apikalhöcker, *4*, am Schnittpunkt der Dorsalrippe mit der Spitzenleiste; er ist fast immer viel kleiner als der Haupthöcker, fehlt aber ebenfalls nur selten; ganz ausnahmsweise steht auch noch ein fünfter Höcker in der Dorsalreihe, am Schnittpunkt mit der Postapikalleiste: der Postapikalhöcker, *8*.

Auf der äusseren Rippe können vorn zwei Höcker stehen: der Humeral, *5*, und hinter ihm der Posthumeral, *6*.

Als letzter erübrigt noch der schon erwähnte Marginalhöcker, *7*, an der Stelle, wo sich die Apikalleiste und ihre Anhänge gabeln.

Selbstverständlich gibt es keine *Hoplionota*, die alle diese Skulpturen aufweist; im allgemeinen sind die Dorsalrippe und die Mittelleiste meist kräftiger als die anderen; ebenso ist der Haupthöcker mit wenigen Ausnahmen gut entwickelt, während die anderen Höcker, insbesonders jene der Humeralreihe oft erlöschen.

Die beiliegende schematische Zeichnung kann vielleicht zum besseren Verständnis der obigen Bezeichnungen beitragen.

Tabelle der Hoplionota-Arten von den Philippinen.

1 (8). Die Höcker der Dorsalreihe fehlen vollständig; insbesonders ist der Haupthöcker auch nicht einmal angedeutet, da die Dorsalrippe ohne Höhendifferenz über seine Stelle hinwegführt und nicht von der Mittelleiste geschnitten wird; von den Querleisten sind höchstens einzelne Reste erkennbar.

2 (5). Auf jeder Flügeldecke sind zwei schwarze Flecke. Querleisten fehlen ganz.

3 (4). Die beiden schwarzen Flecke liegen an der Naht, der erste an der Basis, der zweite in der Mitte. Rötlichgelb. Die Dorsalrippe ist gleichmässig schmal, niedrig, an der Postbasalstelle einwärts, an der des Haupthöckers auswärts gebogen; die Humeralrippe ist vorne schwach und dort, wo sie sich mit der (fehlenden) Pontalleiste schneiden würde, im Winkel gebrochen. 7.75 bis 6 mm. LUZON, Manila. Verh. zool. bot. Ges. 64 (1914) 298 .... *H. braueri* Sp.

4 (3). Die schwarzen Flecke sind quer, der vordere innen verschmälert, von der vorletzten Punktreihe bis über die Dorsalrippe ausgedehnt, der rückwärtige, noch breiter, bildet eine Querbinde von der zweiten bis zehnten Punktreihe. Die Dorsalrippe ist "fast" gerade, die Humeralrippe hinter der Mitte nach aussen gebogen und bald erlöschend. 8 mm. LUZON, Tayabas. Deutsch. Ent. Zeit. (1915) 508.......... *H. quadrisignata* Wse.

Mir unbekannt; vielleicht von der vorigen nicht als Art verschieden. Typus jetzt vermutlich im Museum Stokholm.

5 (2). Die Flügeldecken sind ohne schwarze Flecke, nur mit wenig dunklerer, wischförmiger Zeichnung; die Querleisten sind stellenweise schwach vorhanden.

6 (7). Die Dorsalrippe ist von der Basis bis zur Spitze gerade und von gleicher Stärke, die Humeralrippe viel schwächer, an der Basis und hinter der Mittelleiste erloschen, die Mittel und Spitzenleiste nur aussen von der Humeralrippe erkennbar. Bräunlichgelb, oben wenig dunkler, ein breiter Basalast auf dem Seitendach und eine mit ihm zusammenhängende Längsbinde zwischen Randstreif und Humeralrippe hellbraun; zwischen Dorsal- und Humeralrippe ist ein hellerer Fleck, der beiläufig von der Mittel- bis zur Spitzenleiste reicht. Lang-eiförmig, hinter der Schulter am breitesten. 9 bis 7 mm. MINDANAO, Dapitan. Deutsch. Ent. Zeit. (1915) 508.......... *H. bakeri* Wse.

7 (6). Die Dorsalrippe ist zwischen den Stellen des Basal- und Postbasalhöckers niedrig, fast unterbrochen und nach innen gebogen. Die Humeralrippe bildet mit der Pontalleiste einen unbedeutenden Höcker und ist dann kurz völlig unterbrochen; ihr hinterer Teil ist S-förmig gebogen und wird vom inneren Teile der Spitzleiste weiter hinten als vom äusseren Teil berührt.

Voderecken des Halsschildes mehr verrundet. Scheibe der Flügeldecken mit einer schwärzlich-braunen, wenig auf das Seitendach übergreifenden, innen von der Humeralrippe, hinten von der Apikalleiste begrenzten Langsbinde. 5.5 mm. MINDANAO, Butuan. Deutsch. Ent. Zeit. (1915) 509; mir unbekannt. *H. persimplex* Wse.

8 (1). Die Stelle des Haupthöckers ist erkennbar, entweder durch einen Höcker oder mindestens dadurch, dass sich die Dorsalrippe und die Mittelleiste hier schneiden; auch sonst sind Höcker oder Kreuzungsstellen von Rippen und Leisten vorhanden.

9 (12). Längsrippen fehlen; die Höcker stehen isoliert, ohne Verbindung.

10 (11). Umriss kurz rechteckig; Oberseite rostrot, mit pechschwarzen Erhöhungen; das Seitendach hinter der Mitte unscharf lebhafter rot. Alle Höcker sind niedrig; in der Dorsalreihe vier, hievon der Haupthöcker länger, aber nicht höher, schmal; in der Humeralreihe sind vier Erhöhungen; die erste wird durch die Schulterbeule und die damit zusammenhängende Anfangskrümmung der Humeralrippe gebildet, die zweite durch den gebogenen Aussenteil der Pontalleiste. Die dritte ist quer und ein Rest der furca externa, die vierte knopfförmig und dürfte von der costa ultima übriggeblieben sein. 5.5 bis 4.5 mm. MINDANAO, Dapitan. Philip. Journ. Sci. 18 (1921) 721. *H. dapitana* Sp.

11 (10). Umriss gerundet. Oberseite schwarz mit rostrotem Saum. Die Skulptur der Flügeldecken dieser mir unbekannten scheint der der vorigen Art ähnlich zu sein, doch erwähnt Weise ausser vier Höckern in der Humeralreihe, die jenen der *dapitana* entsprechen würden, noch ein Höckerchen schräg hinten und aussen vom dritten Höcker. Seitenrand aufgebogen, höher und dicker als gewöhnlich. 4 mm. PALAWAN, Puerto Princesa. Philip. Journ. Sci. 18 (1921) 511.................... *H. granulosa* Wse.

12 (9). Es sind Längsrippen vorhanden; allfällige Höcker stehen daher nicht isoliert.

13 (16). Die furca interna fehlt vollständig. Fühler ziemlich lang, bis über die Halsschild-Ecken reichend; die Humeralrippe ist vorne nicht winklig nach aussen gebogen, bis zur Pontalleiste sehr niedrig.

14 (15). Der Haupthöcker ist sehr niedrig und tritt kaum aus der Dorsalrippe heraus; letztere ist zwischen ihm und dem Apikalhöcker fast gleich hoch, also nicht ausgerandet; auch der Apikalhöcker ist sehr klein, noch schwächer als der Haupthöcker. Die Suturalleiste ist sehr schräg nach vorne gerichtet, so dass sie mit der Naht einen Winkel von etwa 45° bildet. Bräunlichgelb, auf den Flügeldecken je zwei pechschwarze Punkte, einer an der Basis zwischen Schulterbeule und Randstreif, unscharf, der andere quer, auf dem Haupthöcker und der Pontalleiste; ausserdem ist ein unscharfer Wisch innen auf dem Seitendach hinter der Brücke. Der Basalhöcker ist länger und niedriger, der Postbasal viel weniger deutlich als bei *modesta*. 6.5 bis 5.5 mm. MINDANAO, Surigao. Philip. Journ. Sci. 28 (1925) 582. ***H. formosa*** **Sp.**

15 (14). Der Haupthöcker tritt deutlich aus der Dorsalrippe heraus, letztere ist zwischen ihm und dem Apikalhöcker eingesenkt, ausgerandet; der Apikalhöcker, sowie die vorderen zwei Höcker sind höher als bei der vorigen Art. Die Suturalleiste geht vom Haupthöcker zur Naht nur wenig nach vorne, so dass sie diese fast unter einem rechten Winkel trifft; der Haupthöcker liegt viel wieter aussen als die anderen der Dorsalreihe. Hell wachsgelb, stark glänzend, die Flügeldecken entweder einfärbig (ab. *nitida* Wse., l. c., p. 511) oder das Seitendach hinter der Mitte mit einer schmalen, wenig dunkleren Binde (Nominatform) oder die Scheibe ausserdem noch mit einem pechbraunen Punktfleck an dem rückwärtigen, äusseren, ausgehöhlten Absturz des Haupthöckers (nicht auf diesem!) [ab. *chapuisi* Sp., Verh. Zool. Bot. Ges. (1913) 523]. 6 bis 5 mm. LUZON, Manila; Los Baños, Mount Maquiling; Rizal, Mount Irid. Mitt. Münch. Ent. Ver 5 (1881) 20 .... *H. modesta* Wagen.

16 (13). Die furca interna ist noch vorhanden, mindestens rudimentär.

17 (34). Der vordere Teil der Dorsalrippe trifft die Mittelleiste weiter aussen als der innere, sie haben also verschiedene Schnittpunkte.

18 (27). Die furca interna geht nach vorne fast parallel zum rückwärtigen Teil der Dorsalrippe und trifft die Pontalleiste weit aussen vom Haupthöcker oder ist kurz vorher abgekürzt; sie bildet fast die Fortsetzung der Humeralrippe.

19 (20). Die furca interna ist vor der Pontalleiste abgekürzt. Oberseite blassgelb, die Scheibe der Flügeldecken gesättigter, braungelb, eine breite, schwarzbraune Längsbinde lässt an der Basis nur den ersten Streif und den letzten Zwischenraum frei, verengt sich dann kurz auf den Raum zwischen dem 5. und 7. Streif, erweitert sich innen wieder bis an den (gelben) Dorsalkiel, überdeckt die Haupthöckerstelle und die Mittelleiste, sowie die aussen von der furca interna gelegene Partie, erreicht hiebei den Rand der Scheibe, wobei sie auf das Seitendach eine breite, abgekürzte, heller braune Binde sendet, und bildet schliesslich einen grossen Fleck auf und hinter der Apikalleiste bis an die Naht. Umriss schmal rechteckig; alle Höcker nur angedeutet; von der Humeralrippe ist nur die Anfangskurve vorhanden. Fühlerkeule sehr kurz und dick. 5.5 bis 4.5 mm. BOHOL. Wagener, Mitt. Münch. Ent. Ver. 5 (1881) 19; Spaeth, Philip. Journ. Sci. 18 (1921) 727 .... *H. vittata* Wagen.

20 (19). Die furca interna erreicht die Mittelleiste. Die Zeichnung der Flügeldecken ist anders.

21 (24). Flügeldecken wenigstens auf einzelnen Höckerstellen schwarz gefleckt.

22 (23) Umriss schmäler rechteckig. Die ganze Mittel- und Spitzenleiste, sowie die Anhänger der letzteren sind mit ihren beiderseitigen Abstürzen schwarz; ebenso der Basal-, Postbasal- und Humeralhöcker; auch die Krümmung der Humeralrippe dürfte mitunter schwarz werden, da sie beim Typus etwas dunkler als ihre Umgebung ist. Oberseite gelblichrot, das Seitendach vor

der Mitte mit einer wenig helleren, unscharfen, am Rande verbreiterten glashellen Makel........................ *H. cavillata* sp. nov.[1]

23 (22). Umriss breiter rechteckig, verhältnismässig kürzer. Oberseite hellrot, auf jeder Flügeldecke sind nur zwei schwarze Querflecke, der vordere auf der Mittel-, der zweite auf der Spitzenleiste, beide zwischen den Längsrippen und noch über deren Schnittpunkte mit den Querleisten hinausreichend. Seitendach ohne Zeichnung. Die vier Höcker der Dorsalreihe ragen über die Rippe deutlich hinaus, obwohl sie niedrig sind. Annähernd rechteckig, mit der grössten Breite erst kurz vor der Mitte der Flügeldecken. Seiten des Halsschildes nach vorne etwas schräg verengt, die (falschen!) Vorderecken mehr zugerundet. 6.75 bis 6 mm. NEGROS, Cuernos Mountains. Philip. Journ. Sci. 28 (1925) 583 .... *H. negrosia* Sp.

24 (21). Flügeldecken ohne schwarze Flecke. Die Schnittpunkte in der Dorsalreihe ragen nicht über die Rippe heraus, es fehlen daher hier die Höcker.

25 (26). Die Humeralrippe ist vorne schwach winkelig auf den 8. Zwischenraum nach aussen gebogen. Umriss kürzer und breiter, nach hinten mehr verengt. Oberseite dunkel blutrot, Halsschild, Schildchen und Seitendach etwas heller blutrot. Seiten des Halsschildes nach vorne mehr schräg, mit breiten, verrundeten

[1] *Hoplionota cavillata* sp. nov. Ziemlich breit, rechteckig, an der Seite kaum erweitert, wenig glänzend, gelblich rot, nur das Seitendach vorne etwas heller und die erhabenen Stellen der Flügeldecken pechschwarz. Fühler ziemlich kurz, nicht bis zu den Hinterecken des Halsschildes reichend; die vier Endglieder der Keule sind dicker als lang. Kopfplatte vor die Augen ziemlich vorgezogen, aber nicht erweitert, vorne zugerundet. Halsschild doppelt so breit als lang, die Seiten vor den rechtwinkeligen Hinterecken zuerst ganz kurz senkrecht zur Basis, dann in gleichmässigem Bogen schräg nach vorne gebogen; der Kopfausschnitt tief, dreieckig, die Scheibe glatt, mit zwei Quereindrücken, von denen der vordere kaum, der rüchwärtige tiefer punktiert ist; die Querfalte zwischen beiden ist flach. Flügeldecken an der Basis kaum breiter als der Halsschild, mit wenig gerundeten, ganz vorne breitesten Seiten. Die Scheibe mit groben Punktstreifen und niedrigen, aus den Rippen kaum herausragenden Höckern; die Dorsalrippe ist zwischen dem 1. und 2. Höcker unterbrochen, die Humeralrippe vor der Pontalleiste undeutlich, vorne auf den 8. Zwischenraum winkelig nach aussen gebogen; der vordere Ast der Dorsalrippe schneidet die Pontalleiste etwas mehr aussen als der rückwärtige; die furca interna verläuft zu dem letzteren fast parallel und bildet eine fast geradlinige Fortsetzung der Humeralrippe; die Suturalleiste geht quer und endet im 2. Streif. Seitendach auf dem hyalinen Fleck geglättet. 5.25 bis 4.5 mm.

In der Körperform der *H. taeniata* verwandt, aber an dem Verlauf der furca interna und den viel niedrigeren, kaum angedeuteten Höckern leicht zu erkennen.

Das einzige Stück in der Sammlung des Herrn W. Schultze trägt die Etikette: MINDORO, Mansalay, E. Taylor."

(falschen) Vorderecken. Die Suturalleiste geht sehr schräg nach vorne zur Naht. 6.25 bis 5.25 mm. SIBUYAN. Philip. Journn. Sci. 28 (1925) 579.. *H. sibuyana* Sp.

26 (25). Die Humeralrippe ist kaum bemerkbar, geht aber vorne ohne Bruch zur Schulterbeule. Umriss länger und schmäler, annähernd rechteckig, aber hinter der Schulter am breitesten, dann schwach verengt und hinten abgestutzt. Oberseite hell gelbrot, das Seitendach vor der Mitte mit einer am Rande breiteren, glashellen, aber unscharfen Makel. Seiten des Halsschildes zuerst senkrecht zur Basis, an den verrundeten (falschen) Vorderecken fast rechtwinkelig gebogen.... *H. schultzei* sp. nov.[2]

27 (18). Die furca interna ist entweder stark abgekürst oder gegen den Haupthöcker, bezw. nach innen gerichtet, ohne ihn zu erreichen. Seitendach immer einfärbig.

28 (29). Oberseite einfärbig rostgelb, Vor- und Seitendach kaum heller, letzteres an der Basis unscharf gesättigter. Die Kreuzungsstellen sind gar nicht höher; alle Rippen und Leisten niedrig, schmal, kaum herausgehoben; die Humeralrippe ist fast erloschen, vorne ohne Aussenkrümmung; die Apikalleiste setzt sich nach innen nicht über die Dorsalrippe fort. Umriss rechteckig, hinten kaum verengt; hiedurch, ferner durch helle Färbung,

[2] *Hoplionota schultzei* sp. nov. Ziemlich lang rechteckig, hinter den Schultern sehr schwach gerundet-erweitert, wenig gewölbt, schwach glänzend; Unterseite und Fühler rötlichgelb, Oberseite gelbrot, der Halsschild an den Vorderecken und eine grosse Makel in der Mitte des Seitendaches weissgelb, durchscheinend; letztere ist innen durch den Randstreif scharf abgegrenzt, breit und verbreitert sich nächst dem Aussenrande. Fühler nur mässig lang, nicht bis zu den Hinterecken des Halsschildes reichend, mit langer, doppelt so dicker Keule, deren Glieder mehr als doppelt so dick als lang sind. Kopfplatte zwischen den Augen schmal, vor diese in gemeinsamer Rundung, aber ohne Erweiterung mässig weit vorgezogen. Halsschild gut dreimal so breit als lang, an der Seite nicht kürzer als in der Mittellinie, mit fast rechtwinkelig, aber ganz abgerundeten, umgebogenen, dann senkrecht zur Basis laufenden Seiten und rechtwinkeligen Hinterecken; Kopfausschnitt tief dreieckig; die Scheibe mit einer glatten Querschwiele zwischen zwei punktierten Eindrücken, von welchen der rückwärtige tiefer ist. Flügeldecken vorn kaum breiter als der Halsschild, vor der Mitte am breitesten, aber mit fast parallelen Seiten; die Scheibe ohne Höcker, die Schnittpunkte ragen nicht über die Kiele hinaus; die Dorsalrippe ist vollständig, ihr vorderer Ast trifft die Mittelleiste etwas weiter aussen als der rückwärtige; auch die Humeralrippe ist vollständig, an der Basis ohne Anfangskrümmung; die Apikalleiste und ihre Anhänge sind ebenfalls vollständig, die furca interna trifft die Mittelleiste weit aussen, wenig mehr innen als die Humeralrippe; alle sind sehr niedrig. Seitendach innen auf der hyalinen Makel glatt, sonst wenig dicht, aussen in Reihen punktiert. 6.5 bis 5 mm.

Das einzige Stück wurde von Herrn W. Schultze, dem ich die Art widme, auf Luzon, Provinz Ilocos Norte, Burgos, gesammelt und ist in seiner Sammlung.

niedrigere Leisten, abgekürzte, anders gerichtete furca interna, weniger aussen gelegene Haupthöcker-Stelle, näher aneinander gerückte Schnittpunkte der Dorsalrippe von *sibuyana* verschieden. 6 bis 5 mm. MINDANAO, Surigao. Philip. Journ. Sci. **28** (1925) 580 .... *H. impicta* Sp.

29 (28). Flügeldecken gelb, mit je ein bis drei schwarzen oder pechbraunen Flecken; davon stets einer auf der Haupthöcker-Stelle, die nur ganz unmerklich über die Dorsalrippe herausragt. Die Humeralrippe ist vorne gabelig gespalten, fein und dünn.

30 (31). Flügeldecken nur je mit einem schwarzen Fleck; er steht mit seiner Mittellinie auf der Pontalleiste und reicht beiderseits noch über die Längsrippen hinaus. In Umriss und Skulptur der *sexsignata* sehr ähnlich, mit schräger zulaufenden Seiten des Halsschildes, hinten etwas breiter abgestutzten Flügeldecken, noch schwächerem Kiel des Basalhöckers. Die Stelle des Haupthöckers ist sehr niedrig und ragt über die Rippenkreuzung nicht heraus. 5.5 bis 4.75 mm. MINDANAO, Surigao, Philip. Journ. Sci. **28** (1925) 586 .... *H. corpulenta* Sp.

31 (30). Flügeldecken mit je zwei oder drei dunklen Flecken.

32 (33). Auf jeder Decke sind nur zwei schwarze Flecke, einer an der Basis, innen von der scharfkantigen nach aussen gebogenen Basis des Humeralkiels, dreieckig und von der Basis des Dorsalkiels durch zwei Punktreihen getrennt, der andere quer auf der Mittelleiste und dem Haupthöcker; dieser letztere tritt über die Rippen deutlich heraus, ist also höher als bei *corpulenta* und *undulata;* auch die anderen Höcker sind zwar sehr niedrig, aber doch deutlicher als bei jenen Arten. Umriss trapezförmig, mit der grössten Breite vor der Mitte der Flügeldecken, hinten fast abgestutzt, kürzer und breiter als die folgende Art. 5.5 bis 5 mm. MINDANAO, Butuan. Philip. Journ. Sci. **28** (1925) 584. *H. delicatula* Sp.

33 (32). Auf jeder Decke sind drei dunkle Flecke; der erste an der Basis, den ganzen Raum zwischen den zwei Längsrippen ausfüllend, der zweite auf der Mittelleiste, gross, quer, nach hinten bis an den Scheibenrand verlängert, so dass nur ein kleiner heller Fleck freibleibt, der dritte auf der Apikalleiste, hinten fast bis an den Scheibenrand reichend. Die Höcker treten kaum merklich über die Rippen hinaus.

Beim Typus von *undulata* sind die Flecke unscharf, braun (unausgefärbt), der Basalfleck in seiner äusseren Hälfte verloschen. Die *Hoplionota sexsignata* Wse., bei der diese Flecke tief schwarz sind, scheint mir nicht artlich verschieden. 6.5 bis 5.5 mm. MINDANAO. Wagener, Mitt. Munch. Ent. Ver. **5** (1881) 18; Spaeth, Philip. Journ. Sci. **18** (1921) 727; Syn. *sexsignata* Wse., Deutsch. Ent. Zeit. (1915) 510. *H. undulata* Wagen.

34 (17). Die beiden Teile der Dorsalrippe treffen sich auf dem Haupthöcker in dem gleichen Schnittpunkt.

35 (36). Der Apikalhöcker fehlt vollständig; die Apikalleiste fehlt aussen von der Dorsalrippe; innen ist sie durch eine kurze, gegen die Naht gehende Leiste noch angedeutet; die Anhänge der Apikalleiste sind durch eine kurze Gabelung markiert. An der Stelle des Apikalhöckers, über die die Dorsalrippe ohne Höhenveränderung führt, steht auch kein schwarzer Fleck. Von den drei schwarzen Flecken steht einer an der Basis, den Raum zwischen Humeralrippe und Aussenrand ausfüllend, der zweite schwach quer, auf und um den Haupthöcker, aussen nur bis zum Schnittpunkt des Humeralkiels mit der Pontalleiste reichend, der dritte rund, hinter der Pontalleiste, je zur Hälfte auf Scheibe und Seitendach. Die Humeralrippe hat vorne keine Aussenkrümmung, die beiden vorderen Höcker der Innenseite fehlen; Umriss fasst quadratisch, breiter und kürzer als bei den folgenden Arten, weniger gewölbt, mit viel breiterem Seitendach. 6.5 bis 5 mm. LUZON, Tayabas, Mount Banahao. Deutsch. Ent. Zeit. (1915) 509 .... *H. sexnota* Wse.

36 (35). Die Apikalleiste berührt beiderseitig die Dorsalrippe; der Apikalhöcker ist als solcher erkennbar.

37 (40). Die Humeralrippe verläuft bis zur Basis geradlinig auf dem sechsten Zwischenraum, ohne vorher nach aussen gebogen zu sein oder einen Ast zum achten zu entsenden. Seitendach hinter der Mitte mit einem roten Ast oder Fleck.

38 (39). Umriss kurz quadratisch-subtrapezoidal, kaum länger als breit, mit der grössten Breite vor der Mitte der Flügeldecken, oberseite hell braungelb; im inneren rückwärtigen Absturz des Haupthöckers ist eine grössere, in rückwärtigen, äusseren des Apikalhöckers eine ganz kleine, nur punktförmige, pechbraune Makel; hinter der Mitte des Seitendaches ist eine schmale, rötliche Querbinde bis zum Aussenrand. 5 bis 4.5 mm. BASILAN. *H. basilana* sp. nov.[3]

[3] *Hoplionota basilana* sp. nov. Etwa vom Umriss der *taeniata* ziemlich breit quadratisch; die Flügeldecken sind an der Basis nicht breiter als der Halsschild, dann noch kurz, sehr wenig erweitert, noch vor ihrer Mitte am breitesten, hierauf schwach konvergierend und hinten breit abgestutzt verrundet. Die Fühlerspitze erreicht nicht die Hinterecken des Halsschildes, ihre Endglieder sind merklich breiter als dick. Kopfplatte vor die Augen ziemlich weit vorgezogen und schwach erweitert, an der Spitze ohne Einschnitt gerundet. Halsschild mehr als doppelt so breit als lang, mit tiefem Kopfausschnitt, fast in rechtem Winkel gerundeten, hinten zur Basis senkrecht verlaufenden Seiten; die beiden Quereindrücke der Scheibe sind flach, kaum deutlich punktiert. Auf den Flügeldecken its die Dorsalrippe zwischen den zwei ersten Höckern kurz unterbrochen, die Humeralrippe vor der Pontalleiste deutlich, vorne aber erloschen, ohne Spur einer Anfangskrümmung nach aussen; die Suturalleiste erreicht nicht die Naht, die Apikalleiste ist kräftig, ihre Anhänge sind nur rudimentär. In der Dorsalreihe sind die beiden vorderen Höcker klein, der Haupthöcker viel höher, wenig niedriger als an der Basis breit, vierkielig, mit einem gemeinsamen Schnittpunkt; der Apikalhöcker ist niedrig.

39 (38). Gerundet-eiförmig, mit der grössten Breite erst hinter der Mitte der Flügeldecken, dann in flachem Bogen gerundet. Seitendach hinter der Mitte mit einem ziemlich breiten, hellroten Querast bis an den Rand, sonst wie die Vordach des Halsschildes hellgelb, fast glasig; Halsschild und Scheibe der Flügeldecken rötlichgelb, letztere zuweilen aussen dunkler braun, die Höckerspitzen unscharf pechbraun. Der Umriss dieser dunklen Färbung entspricht annähernd den Formen der hinteren schwarzen Flecke bei *sexsignata*. Die Dorsalrippe ist zwischen den ersten zwei Höckern kaum, zwischen den zweiten und dritten tiefer eingesenkt; der Haupthöcker ist doppelt so hoch als die anderen Höcker, halb so hoch als an der Basis breit; die Suturalleiste verläuft fast quer, die Pontal ist kräftig, die Apikal und deren gut ausgebidete Anhänge sind viel niedriger. 6.5 bis 5.5 mm. LUZON, Mount Banahao. Philip. Journ. Sci. **18** (1921) 723.
H. hedysma Sp.

40 (37). Die Humeralrippe ist vorne nach aussen gebogen; zuweilen setzt sie sich auch noch auf dem sechsten Zwischenraum schwächer zur Basis fort, so dass sie gegabelt ist.

41 (42). Seitendach mit zwei breiten, scharf ausgeprägten Randästen von der gleichen Färbung oder nur wenig heller als die Scheibe; dazwischen ist eine grosse, bis an den Rand reichende und hier breitere Fenstermakel glashell, ebenso die ganze Spitze; die Scheiben des Halsschildes und der Flügeldecken sind pechschwarz, zuweilen heller braun oder braunrot; einzelne Stellen sind besonders auf dem Halsschild oft heller. Halsschild mit gelb-glasigen Vorderecken. Kurz trapezförmig, wenig länger als breit, hinter der Schulter am breitesten und dahinter schräg konvergierend. Die Dorsalrippe ist vollständig, schneidet die Mittelleiste im gleichen Schnittpunkt, nur ganz ausnahmsweise sind zwei solche knapp nebeneinander; von den vier Höckern der Dorsalreihe ist der Haupthöcker halb so hoch als unten breit, die anderen sind niedriger; die Apikalleiste und ihre Anhänge sind etwas höher als die Humeralrippe. In der Skulptur ganz gleich mit *taeniata*, aber durch die dunkle Färbung der Oberseite (die einzige Art von den Philippinen!) verschieden. 4.75 bis 4.25 bis 5 bis 4.5 mm. LUZON, Baguio, Benguet. Philip. Journ. Sci. **18** (1921) 724................ *H. benguetina* Sp.

42 (41). Seitendach ohne scharf ausgeprägte Randäste und auch ohne gut abgegrenzte, glashelle Fenstermakel. Das Seitendach ist entweder einfärbig rotgelb, oder in der Mitte zwischen zwei wie die Scheibe gefärbten, wenig dunkleren, unscharf begrenzten Randästen innen heller. Oberseite gelb bis braunrot.

43 (44). Die Höcker sind sehr niedrig; selbst der Haupthöcker ragt kaum über die Rippe hinaus. Flügeldecken tim je vier dunklen Flecken, zwei an der Basis nebeneinander, beide länglich, der eine auf der Schulterbeule, der andere auf dem Basalhöcker, einer auf der Mittelleiste quer, der vierte auf und hinter der Apikalleiste. Seitendach einfärbig. 5.25 bis 4 mm. MINDANAO, Surigao. Philip. Journ. Sci. **28** (1925) 587.
H. surigaoensis Sp.

44 (43). Die Höcker treten mehr oder weniger über die Rippe hinaus. Hinter der Apikalleiste ist kein dunkler Fleck.

45 (46). Flügeldecken mit je einem schwarzen Fleck auf der Pontalleiste. Ober- und Unterseite gelb oder rötlich, Seitendach ohne Fensterfleck und Randäste. Umriss rechteckig, die Seiten hinter den Schultern etwas erweitert, dann sehr wenig konvergierend. 5 bis 4.25 mm. LUZON, Verh. zool. bot. Ges. 57 (1907) 137.
H. bipunctata Sp.

46 (45). Flügeldecken ohne gut ausgebildete schwarze Flecke, einfärbig gelb bis rotbraun, oder die erhöhten Stellen der Rippen und Höcker unscharf dunkler, gelbbraun, bis pechbraun.

47 (50). Der Haupthöcker ist so hoch als an der Basis breit, scharf gewinkelt. Seitendach ohne Randäste.

48 (49) Breiter, kürzer, mit kürzerem Halsschild, vorne breiterem, nach hinten mehr verengtem Seitendach. Oberseite hell rostrot, der Halsschild beiderseits des Kopfes, das Seitendach innen vor der Brücke und an der Spitze heller glasig. 5.5 bis 5.25 mm. NEGROS, Cuernos Mountains. Philip. Journ. Sci. 28 (1925) 579.
H. demutata Sp.

49 (48). Schlanker und länger, mit längerem Halsschild und schmälerem Seitendach. Oberseite schmutzig gelbbraun, Halsschild und Seitendach heller gelbbraun, letzteres innen vor der Mitte heller. 5.5 bis 5 mm. MINDANAO, Butuan. Philip. Journ. Sci. 28 (1925) 577 .... *H. butuana* Sp.

50 (47). Der Haupthöcker ist nur halb so hoch als an der Basis breit. Zeichnung und Form nicht ganz konstant; der Umriss ist meist kurz trapezförmig, mit der grössten Breite gleich hinter den Schultern, die Seiten von hier nach hinten schräg konvergierend, die Spitze abgestutzt verrundet; seltener liegt die grösste Breite erst vor der Mitte und die Verengung nach rückwärts ist weniger auffällig. Die Färbung der Oberseite ist gelbbraun bis rotbraun, meist sind einzelne Höckerstellen dunkler braun; das Seitendach hat fast immer eine Andeutung von zwei gesättigter gefärbten Randästen, obwohl besonders der vordere oft so schwach ist, dass er kaum bemerkt wird. Bei der ab. *biramosa* Wagener, Mitt. Münch. Ent. Ver. 5 (1881) 19, sind die beiden Randäste merklich dunkler als das übrige Seitendach und zwischen ihnen ist eine fast glashelle Fenstermakel; bei dem Typus dieser Form sind auch alle Höckerspitzen, die Pontalleiste und ein Wisch vorn zwischen Scheibenrand und Humeralrippe, der bis zur Pontalleiste reicht, hell pechbraun. Alle Höcker sind bei dieser Art niedrig, die ersten zwei der Innenreihe wellenförmig; der Haupthöcker ist vierkantig. Die häufigste und am meisten variierende Art auf den Philippinen. 4.25 bis 3.75 bis 5.75 bis 5 mm. LUZON; SIBUYAN; BALABAC.
H. taeniata F.

ILLUSTRATION

TEXT FIGUR 1. Skulptur der Flügeldecken der *Hoplionota*.

BERICHT ÜBER "EINE NEUE HYDROBIIDÆ VON DEN PHILIPPINEN"

Von Bernhard Rensch
Zoologisches Museum der Universität Berlin

Die von Herrn Dr. J. Begnaert erfolgte Bestimmung der von Dr. Tubangui gesammelten Hydrobiide als *Blanfordia quadrasi*[1] veranlasste mich, die mir übersandten und als *Oncomelania hydrobiopsis* beschriebenen Stücke (letztes Heft des Philippine Journal of Science) norh einmal zu überprüfen. Leider lag mir im Berliner Museum kein Material von dieser Art vor, sodass ich mich ursprünglich auf den Vergleich mit der ohne Abbildung publizierten lateinischen Diagnose O. von Moellendorffs beschränken musste. Danach schien aber die Art micht in Frage zu kommen, da sie als "plicato-striata" beschrieben wird, wahrend die mir vorliegenden Stücke glatt aussahen.

Ich wändte mich nun an Herrn Dr. Haas, der mir freundlicherweise einen Paratyp von *quadrasi* aus dem Besitz des Senckenberg Museums eintauschte. Dieses Stück stimmt in allen Merkmalen mit den mir übersandten Schalen überein, ist aber in der Tat deutlicher "plicato-striata." Da jedoch das Periostracum bei dem Paratyp fehlt, so ist der Strukturunterschied wohl auf diese Weise zu erklären. *Oncomelania hydrobiopsis* moechte ich deshalb, nun keine Verwirrung zu stiften, hiermit wieder einziehen, selbst für den Fall, dass spaeterhin eine entsprechende Differenzierung als geographische Rasse moeglich waere. Moege wenigstens die erstmalige Beschseibung und Abbildung von Radula und Deckel zur Klaerung beitragen.

[1] Philip. Journ. Sci. 49 (1932) 298.

A MARINE CRANE FLY, LIMONIA (DICRANOMYIA) TRIFILAMENTOSA, OF THE PACIFIC COAST OF JAPAN, WITH SPECIAL REFERENCE TO THE ECOLOGY AND THE MORPHOLOGY OF ITS IMMATURE STAGES.[1]

By MASAAKI TOKUNAGA

Assistant in Entomology, Kyoto Imperial University, Japan

THREE PLATES AND TWO TEXT FIGURES

INTRODUCTION

Only the following marine crane flies are recorded in the whole world in spite of the amazing number of crane-fly species of fresh-water habitats:

Trimicra (*Psiloconopa*) *marina* Pierre. Pierre, 1924, Ambleteuse, North France.
Limonia (*Geranomyia*) *bezzii* Alexander and Leonard. Seurat, 1924, Tunis, North Africa.
Limonia (*Dicranomyia*) *signipennis* Coquillett. Saunders, 1928, Newcastle Island, Canada.
Limonia (*Limonia?*) *halophila* Alexander. Alexander, 1929, South Chile and Patagonia.
Limonia (*Geranomyia*) *unicolor* Haliday. Saunders, 1930, North Wales, England.
Limonia (*Dicranomyia*) *monostromia* Tokunaga. Tokunaga, 1930, Seto, Japan.

In addition to the above species Saunders reported that an undescribed marine crane fly had been collected by Edwards on the coast of Chile in 1927 and Prof. J. S. Rogers kindly informed the author that another one, *Limonia* (*Dicranomyia*) *floridana* Osten Sacken, was collected from the *Juncus* marshes of brackish tidal flats of Florida, United States. From Japan three marine crane flies have been collected at Seto, Wakayama Prefecture, including *L.* (*D.*) *monostromia* which was reported

[1] Contribution from the entomological laboratory, Kyoto Imperial University, No. 24.

by the present author in 1930. The other two undetermined species are newly named by Alexander as *L.* (*D.*) *trifilamentosa* and *L.* (*Idioglochina*) *tokunagai*, respectively. Another marine crane fly [2] was obtained at Seto in the summer of 1931, when a few imagines of this species were bred out in the laboratory from larvæ collected from various algæ growing between the tide marks. In the summer of 1931 the author collected again various stages of *L.* (*D.*) *trifilamentosa* Alexander at Seto and certain ecological points of this species were observed there with the help of Mr. N. Omori.

In the present paper the author reports on the larval and pupal stages of *Limonia* (*Dicranomyia*) *trifilamentosa* Alexander based on ecological observations made chiefly in 1931, supplementing those of preceding seasons since 1926, together with morphological studies comparing this species with several other marine crane flies.

These studies were mainly undertaken at the Seto Marine Biological Station of the Kyoto Imperial University under the direction of Prof. Hachiro Yuasa, to whom I am grateful for the help that made these studies possible. I wish to thank Prof. Charles P. Alexander and Dr. F. W. Edwards for suggestions on the marine crane flies. I am deeply indebted to Prof. K. Okada for the use of equipment at Seto. I wish to thank Mr. N. Omori, an advanced student of our laboratory, for his assistance, especially his valuable observations on emergence.

MORPHOLOGY OF THE LARVA

GENERAL REMARKS

This marine crane-fly larva is comparatively small, slender, and cylindrical in general appearance, being 9 to 10 millimeters in length in the spring form and 8 to 8.6 millimeters in the summer form in its full-grown stage. The color of the living larva is semihyaline and yellowish or brownish green, according to the algal color of the habitat. The creeping welts are brown, and arranged six on the dorsal side and six on the ventral side. Thus, the larva is not highly different in general appearance from other marine crane-fly larvæ in respect to its coloration

[2] This species is yellowish, small, about 13 millimeters in wing expanse, lacks both the intermedian crossvein and the proximal deflected part of vein M_3; thus the median cell is wanting. This fly probably belongs to the subgenus *Dicranomyia*.

and creeping welts; but this larva bears characteristic structures on the head, the mouth parts, and the respiratory anal disk. The mandibles greatly resemble those of *L.* (*D.*) *monostromia*, excepting the undentated mola and the plumated brustia of the present species. The mentum is similar to that of *L.* (*D.*) *signipennis* in the number of the teeth and the relative size of the small median tooth, but the anterior outline of *L.* (*D.*) *signipennis* is more convex than that of the present larva. In this larva the postclypeus is well chitinized and distinct and the preclypeus is narrow and transverse; whereas, in *L.* (*D.*) *signipennis* and *L.* (*D.*) *monostromia*, the postclypeus is represented by a membranous area, while in *L.* (*Geranomyia*) *unicolor* both the post- and preclypeus are completely membranous. The hypopharynx of this larva bears six teeth. The salivia also has six large teeth and is provided with three pairs of small lateral teeth. These structures of this species closely resemble those of *L.* (*G.*) *unicolor*. This species, *L.* (*G.*) *bezzii*, and *L.* (*D.*) *monostromia* have the same number of teeth on the hypopharynx, but they differ from each other in that of the salivia. The salivia of *L. monostromia* is flanked with only one pair of small teeth, instead of three pairs, and that of *L. bezzii* is flanked with two pairs of small teeth and in addition has a large unpaired tooth. When the present larva is compared with another marine fly, *L.* (*D.*) *signipennis*, the following distinct differences may be pointed out: On the hypopharynx the latter species is provided with one median tooth beside the six teeth and on the salivia with only four large teeth and one pair of small teeth. In the structure of the maxillæ *L.* (*D.*) *trifilamentosa* has no conspicuous specific characteristics and resembles the other marine species in its general structure. The antennæ of this species are comparatively long; those of *L.* (*G.*) *unicolor* and *L.* (*D.*) *signipennis* are short. Besides the above general appearance the structure of the apical sensory receptors of the antenna is characteristic in each species. The spiracular anal disk of this larva is similar in outline to that of *L.* (*D.*) *signipennis*, but the brown quadrangular or oval spots, which are found on the inner side of the four anal lobes of many crane-fly larvæ, are wanting in the present species.

HEAD CAPSULE

The head capsule is compact, highly chitinized, and incompletely retractile. The main part of the head capsule is divisible

into the dorsal median sclerite, the front, and the paired lateral sclerites, the verticis, by the deep ventral median and the paired, shallow, lateral incisions. The front is shield-shaped, being closely fused with the internal lateral sclerites on its lateral and caudal margins, and on its cephalolateral corners four sensory receptors are found respectively. The vertex is large, mussel-form, and provided with one seta and two large sensory pores on its caudal part. There is one pair of large highly chitinized areas on the head capsule cephalad of the deep lateral incisions.

MOUTH PARTS

The labium is represented only by the dentated mentum, completely losing its palpi and membranous structures. The mentum (*m*) is broad, with seven distinct teeth and one pair of very tiny lateral teeth. The teeth of the mentum decrease in size laterad, excepting the unpaired median tooth, which is small and half as large as the adjacent largest teeth. On the ventral surface of the lateral parts of the mentum there are shallow depressions for the articulation of the subcardines (*sa*). The submentum is also highly chitinized, being divided by a Y-shaped pale stripe from the mentum, extended caudad along the margin of the ventral incision and closely fused with the ventral margins of the verticis. There is a pair of small, chitinized, hook-shaped projections on the mesal margins of the arms of the submentum (Plate 2, fig. 12).

The labral projection is membranous and consists of two large unpaired sclerites on its dorsum and a small paired sclerite on its lateroventer. On the lateral membrane of the clypeal region there are one pair of stiff setæ on the distal part, one pair of long, slender setæ on the proximal parts, and beside these setæ a pair of sensory pegs. The caudal subpentagonal sclerite is the postclypeus (*po*), which is smooth, setæ being wanting. The cephalic, transverse, U-shaped sclerite is the preclypeus (*pe*), which bears two sensory pores and one strong seta on each end of the cephalolateral arms. The distal membranous area, the labrum (*l*), is densely fringed with very strong setæ; the lateral margins of its distomedian area are covered with minute setæ, and its caudolateral corners bear a pair of sensory discs, each of which is furnished with one large and two small blade-shaped setæ and two very minute sensory pegs. Besides these sensory discs the labrum bears two pairs

of sensory pegs and one pair of blade-shaped setæ near the sensory discs. The ventral side of the labrum, the epipharynx, is furnished with a pair of tufts of hairs and a pair of small chitinized sclerites, the tormæ (*tm*) (Plate 2, fig. 11).

The mandible is firmly articulated to the chitinized mandibularia, which is not demarked by a distinct suture from the head capsule, by the large postartis (*pa*) and the triangular preartis (*pr*) and provided with a long extensotendon (*et*), which is attached to the end of the scrobal arm, and a very large retractotendon (*rt*) attached to the mesal concave margin of the mandible. There are four proxadentes (*pd*), of which the apical tooth is sharp and extends distad; the other cutting teeth are more or less broad and extend mesad. Besides these teeth there are two distadentes (*dd*), which are located on the inner side of the mandible and unequal in size, the distal being larger than the proximal tooth. The mola (*ml*) is not dentated and provided with the plumated brustia (*b*) on its proximal end. No hairs are found on the mandible, except the above brustia and a sensory peg located on the base of the scrobal arm (Plate 2, fig. 13).

The maxilla is connected with the vertex by the broad maxacoria (*nc*) and with the mentum by the mesal end of the subcardo (*sa*) and divided into the lateral and the mesal lobes. The lateral lobe consists of a large chitinized plate and membranous area on its proximal region and provided with a blunt, membranous, mesal projection and a short, chitinized, cylindrical projection on its distal region. The chitinized plate, the stipes (*s*), covers most of the area of the external and the ventroental surfaces of the proximal region of this lobe and is provided with two sensory pegs on its laterodistal corner. The broad membranous area of the proximal region of this lobe is provided with a long sensory hair on the distal part of the external side and a longitudinal row of slender hairs on its inner side. Of the two distal projections the inner membranous one is the galea (*gl*), which is fringed with setæ on the lateral and mesal margins but not on the apical margin and its external and inner sides are without setæ and sensory organs. The external projection is the maxillary palpus (*mp*), which is not segmented, is crowned with three tiny sensory pegs on its membranous tip, and is articulated to the ectodistal part of the stipes by the intermediation of a narrow membrane. This narrow membrane is the palpifer (*pf*) and bears a long

sensory peg. The mesal lobe is very broad and consists of two chitinized plates on its external membranous surface, a uniform membranous area on its inner side, and a large, distal, membranous projection. Of these two plates the distal triangular one is the alacardo (*al*), which is broadly expanded onto the external surface of the distal projection and devoid of setæ and sensory receptors. The other obliquely long plate is the subcardo (*sa*), which bounds the proximal part of this mesal lobe and is provided with two long setæ on its lateral end. The broad, distal, membranous projection, the lacinia (*la*), is fringed with large strong setæ on its mesal margin and with slender setæ on the distal and lateral margins and is provided with four large sensory pegs on its ectodistal side. The inner side of the lacinia is covered with minute spinules on its distomesal region (distad of the chain line in the figure). Beside these structures there is a small chitinized plate on the external side of the lacinia along the lateral margin of the alacardo (Plate 2, fig. 14).

The hypopharyngeal region consists of two sharply dentated superimposed plates, forming between them the salivary cavity. At the center, in the caudal part of this cavity, the common salivary duct (*sd*) opens. The anterior plate, the hypopharynx proper (*hx*), is provided with six subequal teeth. The posterior plate, the salivia (*sl*), has twelve teeth, of which the median four are largest and subequal, the next lateral tooth on each side is slightly smaller, and the remaining three teeth on each side are smallest and needlelike. The two posterior arms of the salivia are extended caudad, supporting the lateroventral sides of the salivary cavity, and each is provided with a tendon at its caudal tip. The ventral wall (*el*) of the salivary cavity, between the two arms of the salivia, is setigerous with stiff needlelike bristles. There are three pairs of sensory receptors; two pairs on the cephalic margin of this setigerous membrane and one pair on the proximodorsal sides of the salivial arms. The lateral side of the hypopharyngeal region is supported by the rhombic sclerites, the pharyngea-lingula (*pl*), which bears four tendons, one on each corner. Of these tendons the smallest one connects with the hypopharynx; the dorsocephalic is the pharyngeatendon (*pt*), the dorsocaudal is the liguatendon (*ld*), and the ventrocaudal is the paralinguatendon (*pi*). The small membranous area between the hypopharynx and the pharyngea-lingula bears soft marginal hairs (Plate 2, fig. 15).

ANTENNA

The antenna (*a*) is elongate cylindrical and fitted on the antacoria (*ac*), which is located distad of the thickly chinitized antennaria. On the proximal part of the antenna there is a sensory pore and on the distal membranous end are a mushroom-shaped sensory organ and two small and one large trichoid sensory organs (Plate 2, fig. 9).

THORAX AND ABDOMEN

On the thoracic segments the dorsal creeping welts are completely wanting and the ventral creeping welts are weakly developed on the two posterior segments. The prothoracic segment is subdivided into three annulets, and the cephalic margin of the anterior annulet is fringed with minute spinules; the two posterior thoracic segments are each subdivided into two annulets, and the vestigial creeping welts are found only on the ventral side of these anterior annulets. The abdomen is divided into nine segments; the first abdominal segment is similar in structure to each of the posterior two thoracic segments, excepting in the chætotaxy; the following six abdominal segments are subequal to each other in number of annulets, in arrangement of setæ, and in structure of dorsal and ventral creeping welts, which are found on the anterior annulets. The seventh segment is slightly different from the preceding segments in the arrangement of minute spinules on the posterior margin of its posterior annulet. The small penultimate segment is subdivided into two annulets and both the dorsal and ventral creeping welts are completely wanting. The extreme segment is not subdivided into distinct annulets and at its caudal end is provided with four lobes, which form the spiracular anal disk. The anus is situated on the ventral side of the ultimate segment near the penultimate segment (Plate 1, fig. 8).

The spiracular disk consists of four distinct lobes and its entire margin is fringed with a row of soft marginal hairs. The small dorsal lobe at its distal part is provided with a seta on its dorsal side and a sensory hair among the marginal hairs. The large ventral lobe at its distal part is provided with four setæ accompanied by a minute sensory receptor on its outer side and two large and two small sensory hairs on its inner side. On the inner side of the bases of the paired dorsal lobes there are two ovate spiracles (Plate 2, fig. 10). The setæ on the body, excepting on the extreme segment, are all slender and

tubaculated basally, and sometimes, especially common on the thoracic segments, two or three hairs are situated together on a common membranous tubercle. The small sensory hairs are found in company with the tubaculate hairs. The distribution of the setæ and the sensory hairs is shown in text fig. 1.

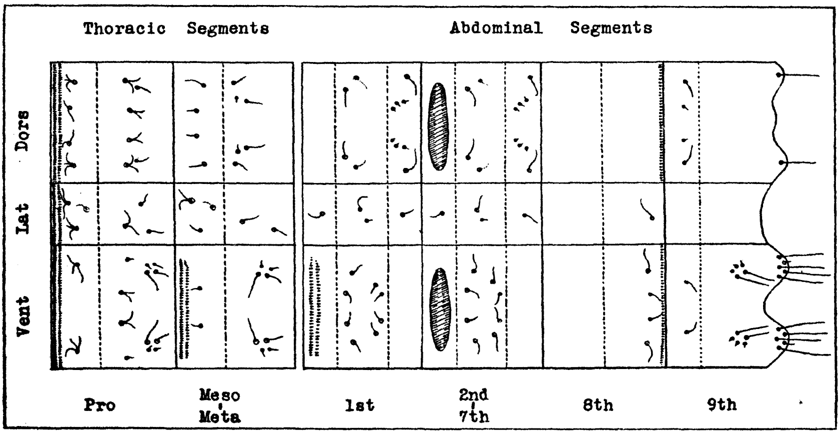

FIG. 1. Arrangement of hairs on the thoracic and abdominal segments of the larva of *Limonia trifilamentosa* Alexander.

MORPHOLOGY OF THE PUPA

GENERAL REMARKS

The pupæ of this species are different in size according to sex and season. The male pupa is smaller than the female and the spring form is larger than the summer and autumn form. They measure 8 to 9.2 millimeters in length in the female and 7 to 7.8 millimeters in the male of the spring form; in the summer and autumn forms they are 6.2 to 7 millimeters and 5.2 to 5.8 millimeters, respectively. The body is slightly yellowish white and semihyaline, excepting the chitinized brown parts such as the respiratory organs, the head parts, the thorax, the wing sheaths, the leg sheaths, and the genital sheaths.

The pupal form of this species is very different from the known pupæ of other marine crane flies in the structure of the thoracic respiratory horns and the genital sheaths and in the arrangement of the creeping welts. The trilobated respiratory organ is unknown in the other marine crane flies. There are five creeping welts on the dorsal side and four on the ventral side. The arrangement of the creeping welts on the dorsal side greatly resembles that of *L.* (*G.*) *unicolor* and *bezzii*, but is different from any of the other marine *Limonia* (*Dicrano-*

myia) species in which the creeping welts are less than five in number, being usually four. On the ventral side the creeping welts are at most three, as in *L.* (*G.*) *unicolor* and *bezzii*, and usually two in other *Limonia* (*Dicranomyia*) species. The genital sheath of this crane fly is also characteristic in the structure of the papilliform projection of the dorsal valve and in the possession of the ventrally curved, hooklike projection of the ventral valve. In all other marine crane-fly pupæ the dorsal projections are curved dorsally and the ventral projections of the ventral valves are wanting.

HEAD

The head part is small, flattened, subhexagonal, and wrinkled on its surface, occupying the cephaloventral side of the body and devoid of conspicuous hairs or tubercles. The main part consists of the broad paired verticis and the small triangular front which are divided by the epicranial suture from each other. The vertex (*v*) is devoid of the crest and split along the thickened epicranial stem at emergence. The caudal margin of the linavertex and the gena is projected laterocaudad and overlies the knee joint of the foreleg sheath and the tip of the maxillary palpal sheath (*mp*). The triangular front (*f*) is indistinctly divided by the wrinkly sutures, the inverted V-shaped epicranial arms, from the vertex and by the transversal frontolabral suture from the labral sheath (*ls*) and provided with three pairs of sensory receptors on its lateral margins. The antennal sheath (*as*) is not provided with spines and hairs, arises above the eye, bends caudad along the lateral margin of the vertex and the outer side of the knee joints of the leg sheaths, and ends at the root of the wing sheath. The compound eye (*ce*) is comparatively larger in the male than in the female and located on the lateral side of the vertex. The labral sheath (*ls*) is small, inverted trapezoid in shape, and situated on the anterior margin of the front. The labial sheaths (*is*) are contiguous and narrow along the anterior margin of the labral sheath overlying the bases of the foreleg sheaths. The sheath of the maxillary palpus (*mp*) is V-shaped, located on the margin of the gena, and overlies the distal end of the femur of the foreleg (Plate 1, figs. 1 and 2).

THORAX AND ABDOMEN

The thorax is well chitinized and consists of a small prothorax, a large mesothorax, and a narrow metathorax. The prothorax

bears a pair of large, characteristic, trilobated, respiratory, horns. The three lobes of this horn are subequal in length and about one-third or one-fourth as long as the body length, but occasionally the length of the lobes is reduced to about one-fifth. The mesothorax is gibbous and highly thickened along its mid-dorsal line. This dorsomedian or mid-dorsal suture is split in the process of emergence. The wing sheath is small, arises at the caudolateral part of the mesothorax, is extended caudoventrad, overlying the lateral half of the sternal region of the metathorax, the first and the second abdominal segments, and ends on the posterior annulet of the second abdominal segment. The leg sheaths are parallel to each other on the ventral side and end on one level on the posterior annulet of the third abdominal segment. The proximal parts, proximad of the tibia, of the middle and the hind leg sheaths are covered over each by the preceding leg sheaths, respectively, and furthermore the tibia and the proximal part of the tarsus of the hind leg sheath are also covered over by the wing sheath. The halter sheath is pale and hidden beneath the wing sheath.

The abdomen consists of eight segments and a genital sheath. The anterior seven segments are provided with rudimental spiracles on their lateral sides, and each is subdivided into three annulets. The penultimate segment is very small and narrow, not subdivided into annulets, and its spiracles are close together on the dorsal side. The dorsal creeping welts are arranged on the anterior annulets of the third to the seventh segment and the ventral creeping welts on the anterior annulets of the fourth to the seventh segment (Plate 1, fig. 1). The structures of the creeping welts are similar to those of the larva, spindle-shaped, and are provided with many chitinized claws, as shown in fig. 7. These claws on the peripheral part are smaller than on the middle part of the welt. The structure of the setæ on the body is similar to that of the larva and their arrangement is shown in text fig. 2.

The genital sheaths of both sexes are highly chitinized, provided with four pairs of setæ on the proximal part; two pairs are on the lateral sides, and the remaining two pairs are on the dorsal side and with a pair of very thickly chitinized, hooklike projections, which curve ventrad on the posterior end. On the female the tip of the genital sheath consists of the incompletely divided ventral valves (*sv*) and the paired dorsal valves (*dv*). The ventral valves are furnished with a pair of strong hooklike projections on the distal part and a pair of blunt lateral projec-

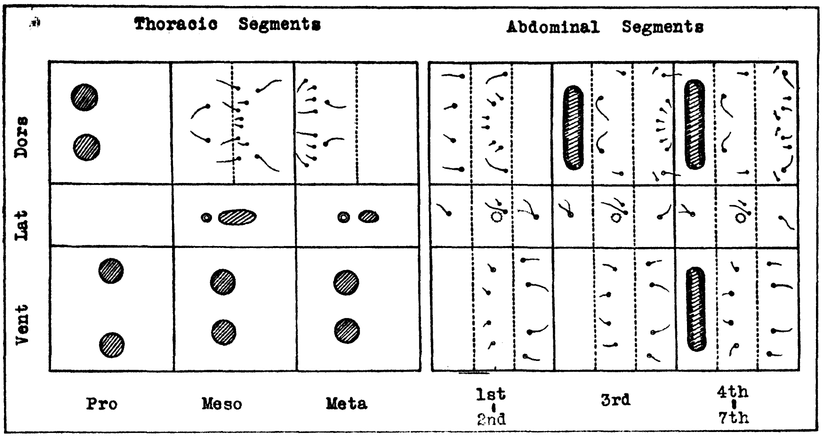

FIG. 2. Arrangement of hairs on the thoracic and abdominal segments of the pupa of *Limonia trifilamentosa* Alexander.

tions on the proximal part. The dorsal valves are provided on the dorsal side with small papilliform projections (Plate 1, fig. 4), each of which bears a minute sensory peg and two slender hairs on the tip and a blunt projection (Plate 1, fig. 3) on the proximal part.

On the male genital sheath the ventral valves extend far beyond the dorsal ones; the hooklike projections are located on the tip of the ventral valves and more sharply curved ventrad, while in the female these are located slightly cephalad of the tip; the lateral projections of the ventral valves are larger than those of the female. The dorsal valves are broader than those of the female and the papilliform projections are located on the proximal part of the genital sheath. This papilliform projection of the male (Plate 1, fig. 6) is more pointed and broader than that of the female and provided with four hairs on its distal part. Besides the above structures there is a pair of deep depressions on the lateroproximal part of the genital sheath of the female and on the dorsoproximal part of the genital sheath of the male (Plate 1, fig. 5).

ECOLOGICAL REMARKS

The adults of this crane fly are found on the seashore throughout the spring and summer seasons at Seto after the first emergence the beginning of April. Late comers may be found in the early autumn, for several imagines were collected in the middle of September. This indicates that this fly repeats its generation more than once a year; and there may be more than two

generations, although this point has not been determined. The immature forms of this crane fly are found on different species of algæ in different seasons, showing that the breeding algal bed of this crane fly is alternately changed according to the seasonal succession of the algal flora of the shore. Through the winter and early spring the habitat of the crane fly is confined to the sea algæ *Ulva pertusa, Ulva conglobata,* and *Monostroma* sp., which are found on the horizontal level of the tidal zone inhabited by certain Mollusca, *Modiolus atratus* Lischke, *Septifer crassus* Dunier, etc. In the later spring and summer seasons these algæ all disappear and the habitat of the crane fly is then other littoral algæ, such as *Myelophycus caespitosus* and *Boodlea* sp.

Generally, both the pupal and the larval nest cases are built under individual plants of these algæ, but when the colonies of this fly are established on the algal matting where the individual algæ are not separated the nest cases are built on the hard rock surface, underneath the entangled thalli of algæ. These nest cases of this species are similar to those of *L.* (*D.*) *monostromia* but are more loosely built than the latter.

Although the breeding places of this crane fly are comparatively limited to several littoral algæ, the feeding habit of the larva is not strictly oligophagous but is sapropolyphagous. The larval stomach contents reveal its wide food habit. The food consists of sedentary diatoms and dead algal filaments mingled with a small quantity of sand particles in addition to fragments of these living algæ which are used by the immature forms for their shelters.

The habitat of this crane fly is regularly submerged under the water in accordance with the tidal rhythm. This rhythmical change of the tidal condition has many effects on the various habits of the crane fly on some of which observations were made to some extent. The stomachs of the larvæ collected immediately after the recession of the tide are found generally empty and only in a very few cases they contained a small quantity of digested food in the hind intestine. While those larvæ collected before the flood tide are without exception filled with the food items throughout the entire midintestine. This indicates rather plainly that the larvæ feed during the ebb tide and refrain from feeding during the flood tide.

The activity of the larva is also affected by the tidal condition. In the natural condition the larvæ remain quietly in their nests at flood tide. In the laboratory a similar condition was

observed by filling the larval quarters deep with sea water at any time of the day. Although the larvæ normally remain in their nests at ebb tide, they sometimes creep out of their nests and may be found moving about on the surface of the algal matting.

Another conspicuous habit that may be related to the tidal rhythm is that of emergence. The emergence of the adult takes place only in the ebb-tide condition. On a suitable algal matting many pupal exuviæ may be found at ebb tide. The emergence commences immediately after the tide has receded and lasts to the next flood tide, the great majority of imagines emerging during about one to three hours after the breeding bed becomes exposed to the air. Before emergence the mature pupæ remain quietly jutting out their respiratory horns from the larval nest, which now serves equally well as the pupal case. When ready to emerge the pupæ wriggle out from their nests and expose their thoracic parts in the air and then remain quiet until the middorsal sutures are split. This process takes one to twenty minutes, varying much in different individuals. After the middorsal suture is split, the emerging process is completed within five to ten minutes, and the freshly emerged milky-colored fly takes to the wing without awaiting the hardening of the integument and the wings. The emerging process was observed in the field and the following data were obtained:

Process of emergence.	No. 1, August 13, 11 a. m.		No. 2, August 26, 10. a. m.	
	m	*s*	*m*	*s*
Pupal thorax wriggled out from algæ	18	00	7	00
Mild-dorsal suture split	40	00	8	30
Thorax of imago began to appear	41	00	8	40
Thorax completely emerged, abdomen and wings began to appear	42	00	8	50
Wing completely emerged	42	40	9	00
Forelegs completely pulled out	42	50	0	00
Body extended in maximum length jutting up perpendicularly	42	52	9	30
Wing expanded	42	53	10	00
Body bent ventrad supported with forelegs	42	55	10	06
Middle and hind legs and abdomen completely emerged	43	10	10	30
Wing folded over the back	43	12	10	31
Quietly resting	43	12	11	00
Walk slowly forward	43	20	0	00
Abdomen contracted to the length of the wings	46	00	13	00
Taken on the wing	50	00	13	30

In the process of emergence the maximum length of the body measured 9.5 (8 to 10) millimeters; the matured normal fly is about 4 millimeters in length. The completely emerged fresh fly becomes normal in color and size within thirty minutes.

The imagines are nocturnal in habit, hence the mature adults are not found at the seashore actively flying after their food, nor for oviposition, mating, or swarming in the daytime, but quietly resting on the vertical or overhanging sides of rocks or in the rock caves along the shore. Occasionally, the adults are collected in the beating net from the bush along the seashore in the daytime. The resting position of this fly closely resembles that of *L.* (*D.*) *monostromia;* that is, the body is closely applied to the substratum with the six legs outstretched like those of a spider. In the twilight of the evening the imagines actively take to the wing from their diurnal haunts and fly about over the rocky shore throughout the night for mating and oviposition.

The mature egg is oval, 248.5 μ in length and 208.1 μ in diameter, and brown with the pointed pole black. The surface of the egg is finely granulated, and at the center of the black-pointed pole is the micropyle, the peripheral area of which is very finely granulated. The female fly contains about 120 mature eggs; most of these eggs are laid during her life, as the spent females are usually devoid of eggs. The eggs are placed singly in the algæ or in the small crevices of the rocks by a rapid up-and-down motion of the whole body produced by the flection of the legs. The presence or absence of algæ does not condition the deposition of the eggs since they are often laid on a completely bare rock. They are never laid on a dry surface whether it be algal or rock.

This crane fly, in all the stages, is subject to attack by many natural enemies, some of which are common with *L.* (*D.*) *monostromia,* for these two crane flies are similar in habitat in the spring season. These common natural enemies are a bat, *Miniopterus schreibersii japoniæ* Thomas, which attacks the adults on the wing; a bird, *Actitis hypoleucos* (Linnæus), which attacks the immature forms; a littoral red mite, *Molgus littoralis* Linnæus, which attacks the adults just in process of emergence; some robber flies, *Antipalus* sp., *Oligopogon* sp., and one other fly, which attack the adults on the wing, and a dragon fly, *Orthetrum japonicum* Uhler, which also catches the adults. Besides the above enemies a spider and some predacious insects, such as a littoral jumping spider, a dragon fly, a tiger beetle, and an anthomyid fly, also attack this crane fly in various stages.

The littoral jumping spider probably belongs to the genus *Salticus;* it usually wanders on the seashore at ebb tide and mainly attacks the imagines in the process of emergence and occasionally also attacks the larvæ creeping on the algæ. The dragon fly *Pantala flavescens* Fabricius, the imagines of which swarm on the seashore in large number in August and September, catches the imagines of this crane fly on the wing. The tiger beetle *Cicindela nivicincta* Chevrolat var. *inspecularis* Horn, which walks on and flies low over the rocks at ebb tide, devours the immature forms of this crane fly and the adults just in process of emergence. The larva of the littoral anthomyid fly, the imago of which mainly attacks the small marine chironomid flies, also attacks the larvæ of this crane fly.

SUMMARY

1. The external anatomy of the larval and pupal forms of a marine crane fly, *Limonia* (*Dicranomyia*) *trifilamentosa* Alexander, is described.

2. The immature forms of this species are distinguished from those of the other known marine crane flies by the following conspicuous characteristics: (*a*) In the larval stage the labrum consists of the chitinized preclypeus and postclypeus; the mentum and hypopharyngeal sclerites are provided with the teeth characteristic in number and size and the respiratory disk is also specific in structure. (*b*) In the pupal stage the characteristic structures are the trilobate paired respiratory horns, the chitinized genital sheaths which are provided with the ventrally curved hooks on the ventral valves, and the creeping welts.

3. The imagines of this crane fly are found from spring to autumn and the generation may be repeated more than once, probably twice or more. The breeding place changes according to the seasonal algal succession. The feeding habit of the larva is neither monophagous nor oligophagous but sapropolyphagous and it seems to take food practically exclusively at the ebb tide. The emergence of the imago is limited to the ebb-tidal condition, and after the middorsal suture is split the process is completed in about ten minutes. The imago is nocturnal in habit. The female contains about 120 well-developed eggs, nearly all of which are laid singly during her life.

4. This crane fly is attacked by various natural enemies in its various stages; namely, the larval stage by a snipe, a littoral jumping spider, a tiger beetle, and an anthomyid larva; the imago

in the process of emergence by a littoral red mite and a littoral jumping spider; and the imago on the wing by a bat, two species of dragon flies, and three species of robber flies.

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ILLUSTRATIONS

LIMONIA (DICRANOMYIA) TRIFILAMENTOSA ALEXANDER

PLATE 1. PUPA AND LARVA

FIG. 1. Female pupa, lateral aspect.
2. Head of the female pupa, frontal aspect.
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4. Dorsal projection of the genital sheath of the female pupa, dorsal aspect.
5. Genital sheath of the male pupa, lateral aspect.
6. Dorsal projection of the genital sheath of the male pupa, dorsal aspect.
7. Various claws of the creeping welt of the pupa.
8. Full-grown larva, lateral aspect.

as, antennal sheath.
ce, compound eye.
dv, dorsal valve.
f, front.
is, labial sheath.
ls, labral sheath.
mp, sheath of the maxillary palpus.
sv, ventral valve.
v, vertex.

PLATE 2. LARVA

FIG. 9. Antenna, lateral aspect.
10. Respiratory anal disk, caudal aspect.
11. Labrum, dorsal aspect.
12. Mentum and its accessory parts, ventral aspect.
13. Mandible, mesal aspect.
14. Maxilla, lateral aspect.
15. Hypopharyngeal region, ventral aspect.

a, antenna.
ac, antacoria.
al, alacardo.
b, brustia.
dd, distadentis.
el, oscula.
et, extensotendon.
gl, galea.
hx, hypopharynx proper.
l, labrum.
la, lacinia.
ld, linguatendon.
m, mentum.
ml, mola.
nc, maxacoria.
pa, postartis.
pd, proxadentis.
pe, preclypeus.
pf, palpifer.
pi, paralinguatendon.
pl, pharyngea-lingula.
po, postclypeus.
pr, preartis.
pt, pharyngeatendon.
rt, retractotendon.
s, stipes.
sa, subcardo.
sd, salivary duct.
sl, salivia.
tm, torma.
v, vertex.

PLATE 3. HABITAT

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17. Summer and autumn breeding bed, consisting of the colony of *Myelophycus caespitosus;* colony at X.

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FIG. 1. Arrangement of hairs on the thoracic and abdominal segments of the larva of *Limonia trifilamentosa* Alexander.

2. Arrangement of the hairs on the thoracic and abdominal segments of the pupa of *Limonia trifilamentosa* Alexander.

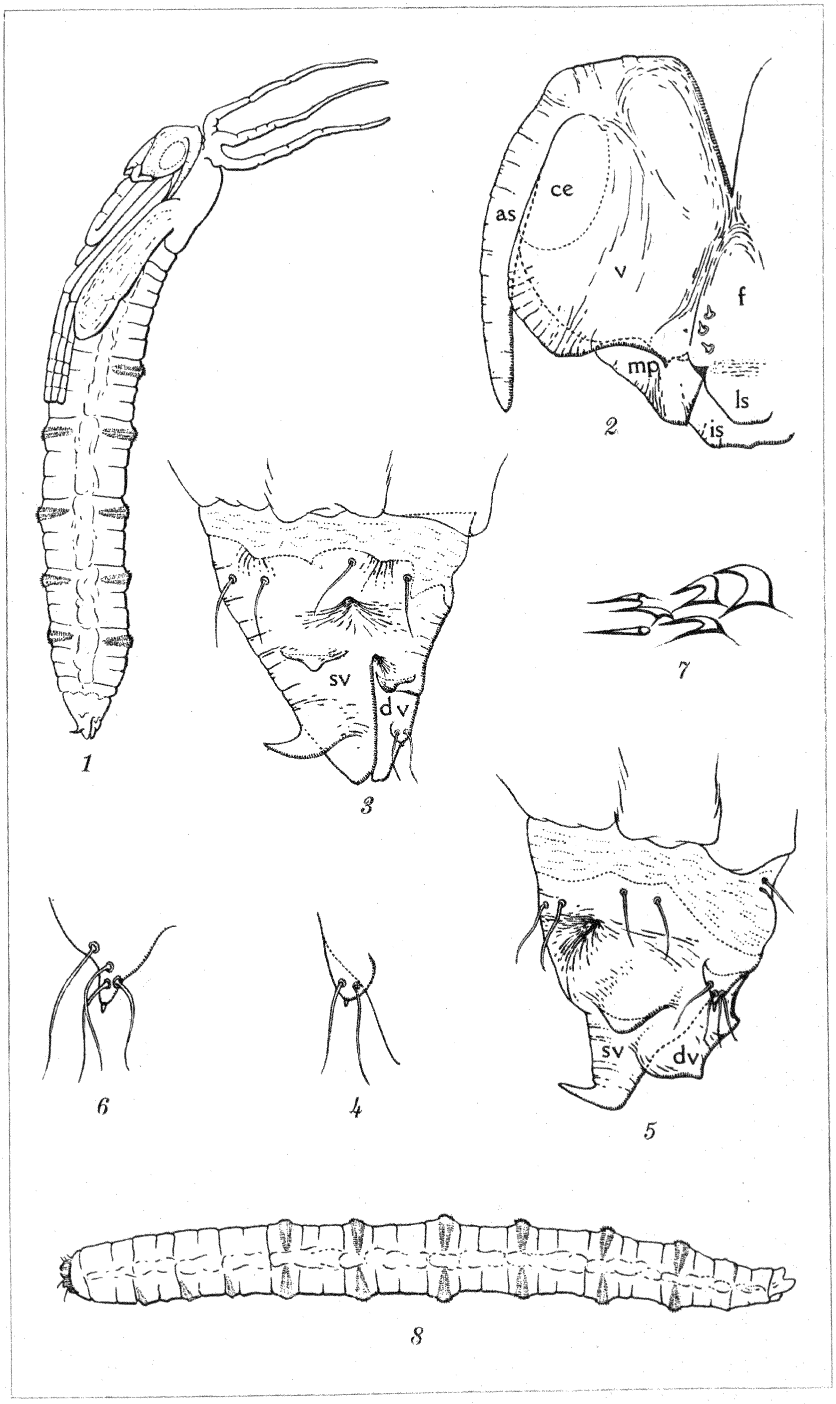

PLATE 1.

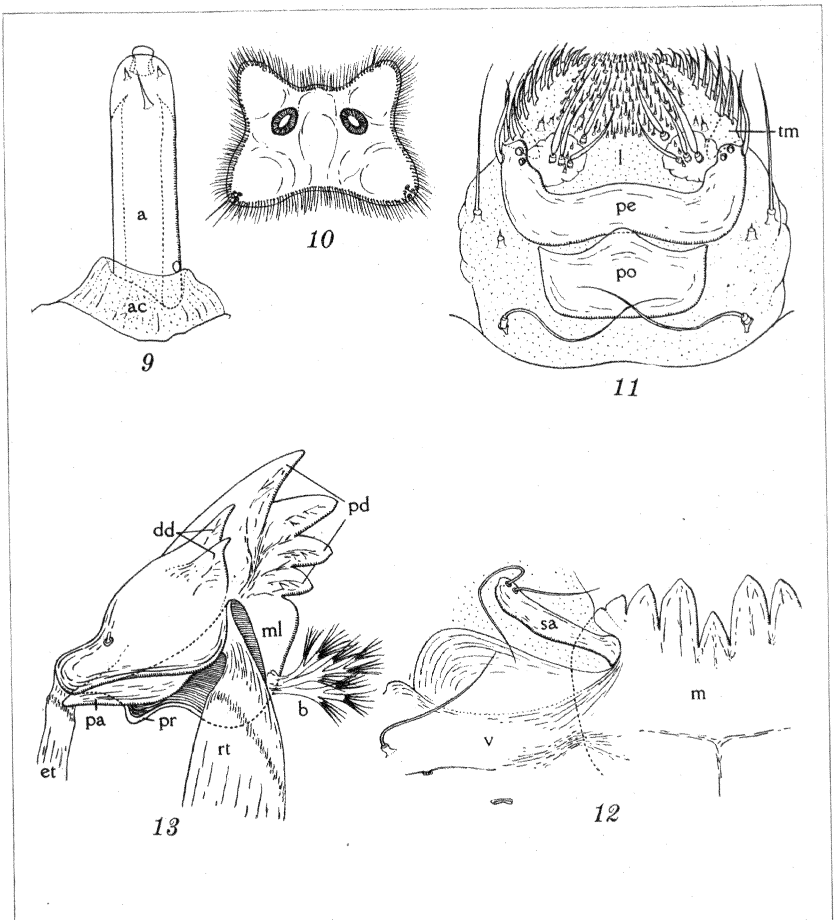
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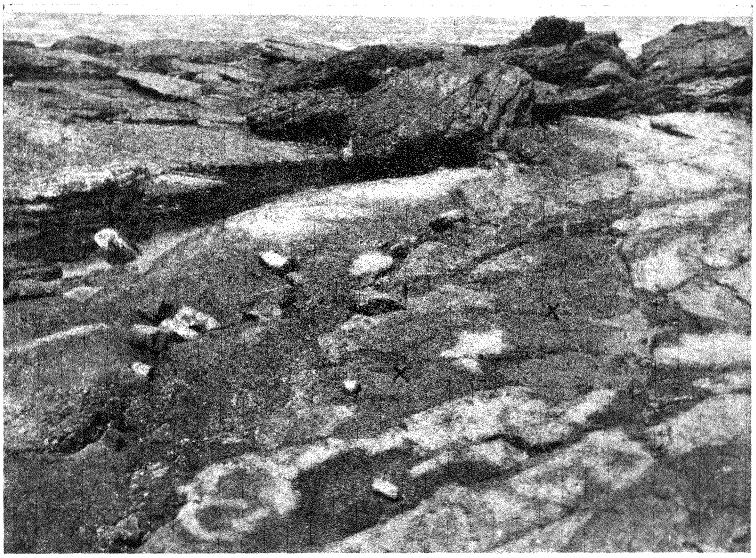
PLATE 2.



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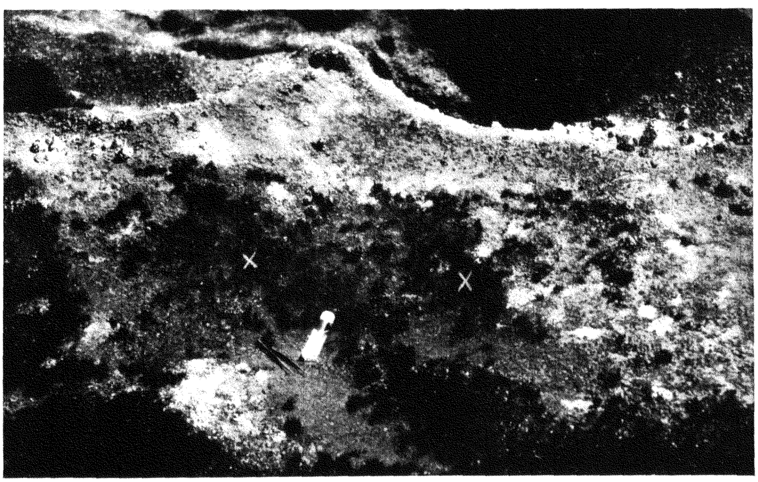

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PLATE 3.

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THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 50 APRIL, 1933 No. 4

PHILIPPINE ALCYONARIA, II

THE FAMILIES ALCYONIIDÆ AND NEPHTHYIDÆ

By HILARIO A. ROXAS
Professor of Zoölogy, University of the Philippines, Manila

FIVE PLATES

Although the littoral alcyonarians of Ternate, Zanzibar, Maldive and Laccadive Islands, and Amboina have been thoroughly worked out, those of the Philippines await a considerable amount of investigation. Prior to 1910 Philippine alcyonaria had been dealt with only incidentally by Wright and Studer (1889) in their Challenger Report, and by May (1899) who described a few specimen collected by Sanderson, Jagor, and Müller. It was thus natural that Light (1913–1915) in a series of papers should deal with several genera of the group. Not satisfied with working alone on this group, he also sent a large part of the alcyonarian collection of the University of the Philippines to Prof. W. Kükenthal, then at Breslau University. A small portion of the collection was worked out by Lüttschwager (1922) and by Kolonko (1926). The greater bulk of the collection, composed of various genera of the Nephthyidæ, was sent later to the Berlin Museum and was entrusted to Prof. J. Moser. When the writer went to Europe for alcyonarian study, he had occasion to study this and compare the representatives of the old collection with the newly collected materials. This work represents the second half of the work on Philippine Alcyonaria done under the joint auspices of the University of the Philippines and the John Simon Guggenheim Memorial Foundation.

Family ALCYONIIDÆ Verrill

Alcyoniidæ VERRILL, Proc. Essex Inst. No. 5 4 (1865) 148.
Alcyoniidæ KÖLLIKER, Verhdlg. d. Phys.-med. Gesellsch. in Wurzburg (1867).
Alcyoniidæ VERRILL, Proc. Essex Inst. 6 (1869) 46.
Alcyoniidæ KLUNZINGER, Die Koralltiere des Roten Meeres. Berlin 1 (1877) 21.
Alcyoniidæ WRIGHT and STUDER, Challenger Report Zoöl. 31 (1889) xviii u. 238.
Alcyoniidæ MAY, Beitrage zur Systematik und Chorologie der Alcyonaceen (1899) 91–99.

The family Alcyoniidæ was first established by Verrill in 1865. Wright and Studer in 1889 included eleven genera under it. These are *Krytallophanes, Bellonella, Nidalia, Paralcyonium, Sarakka, Alcyonium, Lobularia, Sarcophyton, Lobophyton, Anthomastus,* and *Nannodendron.* Later May (1899) removed *Nannodendron* from the family and placed it under Nephthyidæ and united *Bellonella* with *Nidalia,* and *Lobularia* with *Alcyonium.* To the above, *Metalcyonium* Pfeffer (1889), *Daniela* v. Kock, and *Sinularia* May have yet to be added. Finally, Kükenthal (1906) created *Nidaliopsis* and included only eight genera under the family, at the same time dividing *Alcyonium* into three subgenera; namely, *Metalcyonium, Erythropodium,* and *Eualcyonium.* Of all these there are only eight very distinct genera, a key to which follows.

Alcyoniidæ are Alcyonacea in which the colony is divisible into a sterile stem and a polyp-bearing disc or capitulum whose outer surface may appear mushroomlike, branched, lobed, or otherwise provided with long or short processes. The disc in certain cases may also be smooth or simple and poorly differentiated. The polyps are united by a well-developed cœnenchymal mass in such a way that at the stalk the boundaries of the individual polyps are difficult to see. The gastral canals of the polyps are joined to each other by means of canal nets or solenia. Mesenterial filaments are present in all mesenteries. Usually there is polyp dimorphism, but in certain cases the siphonozooids, as a result of retrogressive development, may be absent. The commonest sclerites are sticks, spindles, double spindles, and barrels or cylindroids with warts that may be in the form of girdles.

Key to the genera of the Alcyoniidæ.

a^1. Polyps with calyx, not fully retractile into disc.... Subfamily NIDALIINÆ.
b^1. Sclerites are sticks and spindles.......... *Nidalia.*
b^2. Sclerites are barrels and cylinders.......... *Nidaliopsis.*
a^2. Polyps without calyx, fully retractile into disc.... Subfamily ALCYONIINÆ.
b^1. Entire disc retractile into stalk.......... *Paralcyonium.*
b^2. Disc not retractile into stalk.
c^1. Polyps not confined to disc; may also be on stalk.
d^1. Sclerites of base always large spindles, more than 2 mm long. *Sinularia.*
d^2. Sclerites of base of various types, less than 2 mm long. *Alcyonium.*
c^2. Polyps confined to disc, usually none on stalk, with dimorphism.
d^1. Disc with fingerlike, closed lobes.......... *Lobophytum.*
d^2. Disc with smooth or open folds.
e^1. Sex products produced on autozooids; polyps only on upper surface of disc; species mostly littoral.......... *Sarcophyton.*
e^2. Sex products on siphonozooids; polyps on both upper and lower surfaces of disc; mostly deep-sea forms.......... *Anthomastus.*

Of the above-named genera only *Sinularia, Alcyonium* (subgenus *Eualcyonium*), *Lobophytum,* and *Sarcophyton* have been found in Philippine waters. *Nidalia* is sporadically distributed in Japan, Indian Ocean, and West Australia; *Nidaliopsis* is a deep-sea form, reported only from Congo, while *Anthomastus* is a deep-sea species confined to subarctic and subantarctic portions of the Atlantic Ocean.

Genus SINULARIA May

Sinularia MAY, Mitt. Mus. Hamburg 15 (1898) 24.
Sinularia MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 101.
Sclerophytum PRATT, Alcyon. Maldives Pt. II (1903) 516.
Sinularia KÜKENTHAL, Alcyon. Deutsche Tiefsee-Exp. (1906) 54.
Sinularia COHN, Alcyon. Madagaskar u. Ostafrika, Reise Voeltzkow 2 (1908) 225.
Sinularia LÜTTSCHWAGER, Arch. Naturg. Abtg. A. 10 (1914) 1.
Sinularia KOLONKO, Mitteil. Zoöl. Mus. Berlin 12 (1926) 2.

May in 1898, working out the Alcyonaria of East Africa in the Hamburg Museum, described *Sinularia brassica,* a new genus and species, although he did not work out its internal anatomy. Pratt in 1903, on anatomical grounds, separated a group of animals from Marenzeller's *Lobophytum,* and called it *Sclerophytum,* in which he also included May's *Sinularia brassica.* From all the works reviewed it appears that there is actually

no difference between *Sclerophytum* and *Sinularia*, and therefore the latter name, which is about five years older, must be used.

Sinularia is a genus of Alcyoniidæ where the polyp-bearing disc is not sharply delimited from the sterile stalk. The disc or capitulum is usually composed of fingerlike or lobelike processes in which most of the zooids are located. Siphonozooids are almost always very rudimentary. Stalk cortical sclerites are small clubs with well-developed heads. In stalk cœnenchyma are very large spindles which may be 1 cm long in which, however, the warts or thorns are never arranged in the form of whorls or girdles.

Members of the genus *Sinularia* are confined to the warmer Indo-Pacific waters. With the exception of Port Denison (west coast of Australia), all places where the genus has been reported are within the Torrid Zone, from the east coast of Africa to the middle of the Pacific. There are no less than twenty-nine species and varieties described as belonging to the genus. Twenty-three of these seem to be valid; only ten of them have been encountered in the Philippines.

Key to the Philippine species of Sinularia May.

*a*¹. Colony with fingerlike processes on capitulum.
  *b*¹. A central terminal wart on cortical club head absent.
    *c*¹. Cortical club head branched.
      *d*¹. Basal rim present on stalk .... *S. lochmodes* Kolonko.
      *d*². Basal rim absent .... *S. triaena* Kolonko.
    *c*². Cortical club head unbranched.
      *d*¹. Basal rim present; disc processes not very long.
        *e*¹. Cortical club head not knotty .... *S. leptoclados* (Ehrenberg).
        *e*². Cortical club head knotty.
          S. leptoclados var. *gonatodes* Kolonko.
      *d*². Basal rim absent; disc processes very long and slender.
          S. flexibilis (Quoy and Gaimard).
  *b*². A central terminal wart present on cortical club head.
    *c*¹. Fingerlike processes of disc very short .... *S. mayi* Lüttschwager.
    *c*². Fingerlike processes very long.
      *d*¹. Warts of stalk cœnenchymal sclerites crenulate.
        *e*¹. Fingerlike processes close together.
          S. polydactyla (Ehrenberg).
        *e*². Fingerlike processes spreading.
          S. polydactyla var. *dialichana* Kolonko.
      *d*². Warts of stalk cœnenchymal sclerites not crenulate.
          S. polydactyla var. *mollis* Kolonko.
*a*². Colony with lappetlike processes .... *S. macrodactyla* Kolonko.

SINULARIA LOCHMODES Kolonko.

S. lochmodes KOLONKO, Mitteil. Zoöl. Mus. Berlin 12 (1926) 300, pl. 1, figs. 1–3.

Colony bushy in appearance with a strong stalk, with clear basal line and numerous fine fingerlike processes about 2 mm in diameter. Cortical sclerites are clubs with branched heads but without any central wart.

Colony bushlike in form. From a strong stalk or from a high basal plate, a number of thick upright branches arise. These in turn give off few or many secondary branches. The terminal branchlets are fingerlike processes not more than 50 mm long and 2 to 3 mm wide. They may also arise directly from the main stem. Around the base of the stalk is a clear basal line. The polyps are about 1 mm apart and regularly arranged in smaller processes. In the stalk cortex are clubs 0.07 to 0.1 mm long with a few or many stumpy warts on stalk. The head of the clubs is branched, and is composed of three or more thorns at the tip, which are obliquely directed to the outside just behind which is a ring of strong processes rounded at the ends that stand out almost perpendicularly from the stalk. No wart that may be called central is present. In addition, larger clubs with stalks as long as 0.25 mm with few warts and also slightly bent sticks or spindles 0.2 to 0.45 mm long slightly thickened at one end are present in the cortex. In the stalk cœnenchyma are straight or bent spindles provided with conical or semispherical warts on which are many small knobs. These spindles are from 0.5 to 8 mm long and from 0.06 to 1 mm thick.

Reported from Puerto Galera and Palawan.

SINULARIA TRIAENA Kolonko.

S. triaena KOLONKO, Mitteil. Zoöl. Mus. Berlin 12 (1926) 304, pl. 1, fig. 4.

Colony with thin corrugated stalk and a capitulum divided into rounded branches or flat lobes. Terminal branches are fingerlike lobes rounded at tip. Stem without basal line; head of cortical clubs without a central wart: arms on head limited to three.

Colony with a low disclike base which is slightly folded upwards around the rim. This gives rise to very thick, short, rounded branches, 1 to 2 cm wide and flat lobes, about 3 cm wide that divide in turn to form secondary and tertiary rounded

fingerlike processes as long as 0.5 cm. The polyps on the disc as well as on the primary lobes and branches are arranged in little raised groups. On the processes they are regularly distributed, about 1 to 2 mm apart. Sclerites of the cortex are mostly clubs, 0.15 to 0.17 mm long with a smooth or slightly warted pointed stalk. The head of the clubs is composed of three oblique armlike processes that get thicker at the ends and become divided into two to four short rounded knobs. There is no central wart. Besides the clubs, small, smooth, spindlelike sticks 0.1 to 0.2 mm long and 0.02 mm wide are also present in the cortex. In the cœnenchyma are spindles 1 cm long and 1 mm wide. They are covered with large, semispherical or conical warts with many small knobs.

Type obtained from the canal between Palawan and Mataguit Islands.

SINULARIA LEPTOCLADOS (Ehrenberg). Plate 2, fig. 8.

Lobularia leptoclados EHRENBERG, Corallth. Roten Meeres (1834) 58.
Sinularia leptoclados LÜTTSCHWAGER, Arch. Naturg. Abt. A. Heft 10 (1914) 3.

Colony encrusting or bushlike with fingerlike processes. Cortical clubs with unbranched head and without a central wart. Stalk has a definite basal line.

Colony encrusting or bushlike, the basis definitely set off from the rest of the stalk by the basal line. The stem has few or many longitudinal furrows, while the capitulum is slightly enlarged and not much branched. The terminal processes are sometimes fingerlike, sometimes only slightly longer than wide. Polyps are regularly distributed on the capitulum, about 1 mm apart. They may occasionally be found also on the stem. Siphonozooids are fully rudimentary. Cortical sclerites are small clubs, 0.05 to 0.12 mm long with head 0.025 to 0.03 mm wide. The head is unbranched and is made up of many obliquely directed elongate knobs or stumpy warts that are closely crowded together. Central wart absent. The stalk is almost smooth except for a ring of a few small knobs near its almost blunt end. A few clubs are larger, 0.08 to 0.15 mm long, with similar head but with stalk provided with few and short warts. In addition sticklike or spindlelike bodies, 0.1 to 0.25 mm long and 0.02 to 0.035 mm wide, are also present on the stalk cortex. In the cœnenchyma are straight or bent spindles up to 7 mm long and 0.6 mm wide with slightly rounded ends. They are provided

with warts that are either large, stumpy, and granular, or rather rugged and standing together in small heaps.

Reported from Ceylon, Amboina, Western Australia, and the Red Sea. Philippine material obtained from Batas Island, Taytay Bay, and Puerto Galera Bay.

SINULARIA LEPTOCLADOS (Gray) var. **GONATODES** Kolonko.

S. l. var. *gonatodes* KOLONKO, Mitteil. Zoöl. Mus. Berlin 12 (1926) 309, pl. 2, fig. 1.

Outer appearance of colony similar to that of the typical species except that the branches do not diverge so strongly. The polyps are visible from just above the sharp basal line where they are found in large numbers. Besides the typical clubs found on the stalk cortex of the typical species, numerous clubs, on the average 0.125 mm long, with strongly warted stalk, are found. The small processes on the head are so closely crowded together that they appear like a simple knotty mass from which only the stumpy ends of the warts extend slightly. In addition, small sticks about 0.25 mm long, with a somewhat thickened end where the small knobs are more thickly crowded, are present on the cortex. Small irregular calcareous bodies are also seen. Sclerites of stalk interior are small spindles, 1 to 3 mm long and 0.2 to 0.35 mm wide, covered with numerous strongly crenulate warts.

Type of variety from Batas Island, off the east coast of Palawan.

SINULARIA FLEXIBILIS (Quoy and Gaimard). Plate 2, fig. 10.

Alcyonium flexibile QUOY and GAIMARD, Voy. Astrolabe 4 (1833) pl. 23, figs. 1–3.

Sinularia flexilis (err.) LÜTTSCHWAGER, Archiv. Naturg. Abt. A Heft 10 (1914) 11.

Colony tall, bushy, with very long, slender, tubelike processes of disc. Stalk without basal line. Sclerites absent from terminal processes. Cortical clubs with unbranched head without a central wart.

Colony very bushy in appearance. Stalk cylindrical, columnar and usually tall without any distinct boundary between the calcareous base and the rest of the stalk. This divides into primary, secondary, and tertiary branches which are very sensitive to touch. Tertiary branches contract tremendously when fixed and in this condition are usually about 3 mm in diameter. They are very long, fingerlike or tubelike, completely devoid of

sclerites. In contracted specimens autozooids are closely set, usually less than 0.5 mm apart, especially on the tertiary branches. Cortical sclerites are irregular clubs 0.06 to 0.13 mm long, more or less triangular in general outline, with irregularly placed warts. Club head unbranched, knotty in appearance, composed of several stumpy warts, while the end of stalk is more or less pointed. Besides the clubs, there are other irregular tiny calcareous sclerites. Stalk interior full of large spindles 0.7 to 2.5 mm long and 0.2 to 0.4 mm wide with thickly set, low, almost rounded warts.

Colonies usually very large.

Reported from Vanikoro, Fiji, Amboina, Samoa, Pelew Islands, and Cebu and Mindoro, Philippines.

SINULARIA MAYI Lüttschwager. Plate 2, fig. 6.

S. mayi LÜTTSCHWAGER, Arch. Naturg. Abt. A Heft 10 (1914) 6.

Colony either medium in height or very low and flat but always with a slightly expanded disc on which numerous, short, fingerlike lobes of uniform length are present. Clubs with a central wart; sclerites of stalk may be more than 4 mm long. Basal line absent.

Colony either with a strongly developed stem with many longitudinal ridges and broadened capitulum which is slightly branched, or the colony may be just a low flat disc with its outer part thrown up into a collarlike rim. The numerous lobes of the disc are short, closely set, mostly flattened laterally and almost of the same height all over. Although the polyps are confined to the capitulum, there is no sharp line separating the polyp-bearing and sterile portions of the colony. Sclerites of cortex are small clubs 0.07 to 0.12 mm long, with heads 0.04 to 0.06 mm wide. The head is a large, tripartite structure, with one central and two more or less horizontal arms. All these arms may carry one or more small knobs. Towards the stalk of the club few knobs sometimes arranged ringlike are present. Besides these smaller clubs, there are very few larger ones, reaching 0.18 mm long and 0.05 mm wide with fewer larger stumpy warts that are not arranged in a regular radiating manner as in the smaller clubs. In addition, small poorly warted sticks and spindles, about 0.15 mm long and 0.035 mm wide, are also present on the cortex. Sclerites of the stalk interior are straight or slightly bent spindles, 1 to 4.5 mm long and as much as 0.4 mm wide, with simple or compound warts.

This species was formerly included under *S. polydactyla* by Burchardt. Unlike this, however, *S. mayi* has the lobes not lying one over the other, but closely arranged, one after another and more or less flattened laterally.

SINULARIA POLYDACTYLA (Ehrenberg). Plate 2, fig. 7.

Lobularia polydactyla EHRENBERG, Corallth. Roten Meeres (1834) 282.
Alcyonium polydactyla DANA, Zoopytes (1846) 617.
Amocella polydactyla GRAY, Ann. & Mag. Nat. Hist. 3 (1876) 125.
Sclerophytum polydactyla PRATT, Alcyon. Maldives pt. 2 (1902) 524.
Sinularia polydactyla COHN, Alcyon. v. Madagascar und Ostafrika, Reise Voeltzkow (1908) 229.

Colony encrusting, or with a rugged, long or short, sterile stalk and a capitulum with large, flattened, closely crowded, fingerlike processes that arise from lobelike branches. Clubs provided with central wart; inner stalk sclerites over 3 mm long and with crenulate warts.

Colony either more or less encrusting or columnar. In the encrusting form, the disc is more or less distinctly set off from the very short stem by means of a slightly undulating rim. In the columnar form, such a rim is absent; the stalk is irregular, thrown up into large or small longitudinal folds, and the disc is composed of several large, rounded or flattened branches which again subdivide into a number of elongate fingerlike processes several centimeters long. Basal rim is either indefinite or entirely wanting. Autozooids mostly confined to disc of colony, 0.5 to 1.5 mm apart. Cortical clubs are 0.075 to 0.175 mm long and with a head 0.03 to 0.07 mm wide. The head is provided with three warty arms which stand almost perpendicularly from the stalk, and a single isolated knotty central wart at tip. The next rows of warts are located about middle of stalk. Other smaller warts are found towards the slightly rounded end of club stalk. Small sticks and spindles up to 0.25 mm long and 0.04 mm wide, with few and short rounded warts, are also present. In addition there are a number of very irregular small bodies, which at times may be three-rayed or four-rayed. In stalk cœnenchyma the sclerites are spindles up to 5 mm long and 0.04 mm wide with pointed ends.

SINULARIA POLYDACTYLA (Ehrenberg) var. **DIALICHANA** Kolonko.

S. p. var. *dialichana* KOLONKO, Mitteil. Zoöl. Mus. Berlin 12 (1926) 325, pl. 4, fig. 3.

Colony with an almost smooth sterile stalk which is slightly enlarged towards the base as well as towards the capitulum.

Capitulum composed of a number of primary branches that arise at an angle from the stalk. These give off slender secondary and tertiary fingerlike processes towards their ends. These processes oftentimes are entangled among each other and then diverge strongly from one another. The polyps are usually 1 to 1.5 mm apart. Besides the typical sclerites found in the typical species, there are in the cortex other plump clubs with strongly developed central warts, as well as numerous overdeveloped clublike forms. Other sclerites are similar to those of the typical species. The spindles with simple finely knobbed warts, found in the typical species, are very seldom seen in this variety.

SINULARIA POLYDACTYLA var. MOLLIS Kolonko.

S. p. var. *mollis* KOLONKO, Mitteil. Zoöl. Mus. Berlin 12 (1926) 325, pl. 4, figs. 4 and 5.

This differs from the typical species in being smaller and in having a less-branched capitulum and much fewer sclerites, which make the colony rather soft and flabby. The clubs of the cortex are stout, 0.12 to 0.2 mm long and 0.05 to 0.7 mm wide. The short processes close under the central wart are usually broad. In stalk cœnenchyma only spindles with simple, finely knobbed warts are present. They are slender, usually 5 mm long.

SINULARIA MACRODACTYLA Kolonko. Plate 2, fig. 9.

Sinularia macrodactyla KOLONKO, Mitteil. Zoöl. Mus. Berlin 12 (1926) 328, pl. 3, fig. 4.

Colony low or encrusting or wide with large, wide, and flat but pointed lobes from the disc. Basal line present. Polyps confined to disc. Cortical clubs are stout, almost pointed, with many warts arranged bushlike at head. Club head unbranched and without a central wart.

Colony low and wide or encrusting with a short stalk with a sharp line between the calcareous base and the rest of the stalk. Disc separated from the stalk by a rimlike boundary. Disc with large lobes that are divided into nearly triangular, flat, pointed, and diagonally inclined processes. Polyps confined to disc. They are large and very prominent, about 1 to 2 mm apart on the lobes and at the external surface of the disc. At center of discs they may be farther apart. Clubs of cortex are 0.08 to 0.15 mm long and 0.04 to 0.07 mm wide at the head. They

are stout, with prominent, pointed, or rounded warts clustered around the head. Club stalk usually more or less pointed. In addition to the clubs, large spindles with irregular warts and spindlelike slender sticks also with few warts are present in the cortex. Sclerites of stalk interior are large spindles reaching 4 mm long and over 1 mm thick with thickly set prominent warts.

Colony of medium size, the one described by Kolonko was 12 by 17 cm wide and 2 to 4 cm high.

Reported only from Puerto Galera, Mindoro, Philippines.

Genus ALCYONIUM Linnæus

Alcyonium LINNÆUS, Systema Naturæ ed. 10 1 (1758) 803.
Alcyonium LAMARCK, Hist. Nat. d. Anim. s. Vert. 2 (1816) 388.
Alcyonium QUOY and GAIMARD, Voyage de l' Astrolabe 4 (1833) 269.
Alcyonium DANA, Zoophytes. Philadelphia (1846) 611.
Alcyonium MILNE-EDWARDS, Hist. Nat. d. Cor. 1 (1857) 114.
Alcyonium GRAY, Ann. & Mag. Nat. Hist. IV 3 (1869) 121.
Alcyonium KLUNZINGER, Die Koralltiere des Roten Meeres 1 (1877) S. 21.
Alcyonium WRIGHT and STUDER, Challenger Report 31 (1889) 238.
Alcyonium MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 102.

The genus *Alcyonium* was established by Linnæus in 1758. Of the three species that he included under the genus, only one, *A. digitatum*, really belongs there. Pallas (1768) enumerated twelve species under the genus, but only a few of these actually belong to it. Lamarck (1816) included forty species under it, but these are almost all sponges, and the three forms which he should have included under the genus were placed by him under another genus, *Lobularia*. In a revision of all previously described species, Milne-Edwards (1857) placed all species of *Lobularia* under the old genus *Alcyonium* and enumerated a total of sixteen species. In 1889, Wright and Studer again revived the genus *Lobularia*. But as there are no true differences by which this can be separated from *Alcyonium*, the name *Lobularia* has been suppressed ever since.

Members of the genus *Alcyonium* are Alcyoniidæ whose colonies are either massive, with a stalk and a disc divided into lobes, or encrusting, or columnar and unbranched. The polyps have no dimorphism. They are located on the outer surface of the colony and are completely retractile. The canal system is very irregular in extent and shows no division into inner and outer parts.

Alcyonium can easily be distinguished from *Sinularia* to which it is closest in external appearance, by the presence of the dumb-bell-shaped sclerites in the cœnenchymal walls and by the smaller size of the stalk sclerites. In *Sinularia* the stalk sclerites are very large, up to 1 cm long. In *Alcyonium* the sclerites are always less than 2 mm long.

Kükenthal (1906) has divided *Alcyonium* into three subgenera; namely, *Erythropodium, Metalcyonium,* and *Alcyonium.* In 1912, Broch changed the name of the subgenus *Alcyonium* to *Eualcyonium. Eualcyonium* is the typical *Alcyonium;* that is, with a massive upright stalk and a capitulum more or less divided into many or few processes. *Metalcyonium* includes all forms that are unbranched and cylindrical or club-shaped, while *Erythropodium* includes all encrusting, membranous forms. *Metalcyonium* is confined to the subantarctic region (Patogonia and South Africa), while *Erythropodium* has been reported only from northern seas, the Atlantic, Mediterranean, and Red Seas and the West Indies. *Eualcyonium* is found in practically all waters. All together there are about nineteen valid species under this subgenus; but only three of these have been reported from the Philippines.

Key to the species of the subgenus Eualcyonium.

*a*¹. Cœnenchymal sclerites, in addition to others, are dumb-bell-shaped double cylinders, spheres, or discs.
- *b*¹. Cœnenchymal sclerites typical dumb-bells.
  - *c*¹. Cortical sclerites double spheres with short neck. .... *A. globuliferum* Klunzinger.
  - *c*². Cortical sclerites biscuit-form.
    - *d*¹. Twigs of capitulum small and round.
      - *e*¹. Twigs closely set, flattened against each other; colony brainlike in appearance .... *A. sphaerophorum* (Ehrenberg).
      - *e*². Twigs far apart and higher............ *A. digitulatum* Klunzinger.
    - *d*². Twigs large and fingerlike.
      - *e*¹. Cœnenchymal sclerites with short thick neck. .... *A. pachyclados* Klunzinger.
      - *e*². Cœnenchymal sclerites with long neck and small thorns on either end .... *A. brachyclados* (Ehrenberg).
- *b*². Cœnenchymal sclerites are slender spindles and sticks or with irregular four-rayed or eight-rayed forms.
  - *c*¹. Simple clubs present in cœnenchyma.
    - *d*¹. Colony with a distinct stalk. .... *A. etheridgei* Thomson and Mackinnon.
    - *d*². Colony without a distinct stalk.
      - *e*¹. Cœnenchymal sclerites, in addition to clubs, are double spheres with slight constrictions.

f^1. Cœnenchymal sclerites include thorny spindles.
A. paessleri May.
f^2. Cœnenchymal sclerites have no thorny spindles.
A. fallax Lüttschwager.
e^2. Cœnenchymal sclerites only double spheres or dumb-bell forms with deep constriction; cortical sclerites are clubs.
A. ceylonensis May.
c^2. No clubs in cœnenchyma.
d^1. Cœnenchymal sclerites are cylindrical, slightly warty forms with weak constriction........................ *A. equisetiforme* Lüttschwager.
d^2. Cœnenchymal sclerites are disclike or warty oval forms.
e^1. Disclike sclerites covered with inconspicuous warts.
A. fauri Thomson.
e^2. Disclike sclerites covered with high warts.
A. valdiviae Kükenthal.
a^2. Cœnenchymal sclerites include no dumb-bell-like forms.
b^1. Sclerites thick, strongly warted spindles.... *A. gracillimum* Kükenthal.
b^2. Sclerites slender spindles and rods, or irregular in form or eight-rayed.
c^1. Colony with slender sterile stalk with slender branches.
d^1. Colony translucent, polyps large and hyaline.
A. palmatum Pallas.
d^2. Colony slightly transparent, polyps large.
A adriaticum Kükenthal.
d^3. Colony slightly transparent, polyps small, yellow.
A. brioniense Kükenthal.
c^2. Colony with short, thick, fleshy branches.
d^1. Branches slender and pointed distally.... *A. glomeratum* Hassall.
d^2. Branches blunt, thick, and rounded.
e^1. Polyps deep red.. *A. compressum* Studer.
e^2. Polyps light, hyaline.................................... *A. digitatum* Linnæus.

ALCYONIUM PACHYCLADOS Klunzinger.

A. pachyclados KLUNZINGER, Korralthiere des Roten Meeres 1 (1877) 24, pl. 1, fig. 5.

Colony more or less fleshy and soft. It has a very short stalk, oftentimes very insignificant, attached to the substratum by a narrower basal portion. The stalk broadens abruptly to form a capitulum composed of a number of processes. The processes are mostly thick, even, stumpy, broad and fingerlike, usually longer than broad. They are usually 3 to 5 mm long, far apart, and hardly touching each other. Polyps may be fully extended or retracted. Cortical sclerites of the stalk are elliptical or 8-shaped discs and larger cylindrical forms, 0.04 to 0.05 mm long and 0.02 mm wide, with few warts. In the stalk cœnenchyma are large dumb-bell-shaped sclerites or double spindles with a middle portion free from warts. In general the neck is not much smaller than the two. At both ends are

numerous rugged irregular warts. These sclerites are 0.08 to 0.1 mm long and 0.06 mm wide with a neck about 0.005 to 0.012 mm long.

Color in alcohol white to brown.

Reported from various parts of the Indo-Pacific region.

ALCYONIUM DIGITULATUM Klunzinger.

A. digitulatum KLUNZINGER, Korralthiere des Roten Meeres 1 (1877) 24, pl. 1, fig. 3.

Colony with a leathery consistence and a short stalk that divides into a number of lobes. These in turn give off on their inner sides several smaller lobes which are usually short and fingerlike. They are usually as long as broad and are not very thickly crowded. Usually the polyps are not fully retracted so that the entire colony appears woolly. Cortical sclerites of the stalk are long-oval elliptical discs reaching 0.05 mm long and 0.016 mm wide, with or without any clear neck, and usually without a definite indentation. The cœnenchymal sclerites of the disc are double spindles with a long handle not much diminished in size and few large warts on either end. The sclerites of the stalk cœnenchymal wall are double spindles 0.07 to 0.08 mm long and 0.06 mm wide with a short narrow neck and greatly enlarged ends.

The Philippine form (C–2211) has a total height of 60 mm and a polypary expanse of 65 mm. Color in alcohol is grayish white, polyps darker.

Reported from the Red Sea and Zanzibar. Philippine material obtained from Batas Island, Palawan.

This form differs from *A. sphaerophorum* in having the lobes not closely crowded and flattened against each other. The colony cannot be called hemispherical in shape as is the case with *A. sphaerophorum*.

ALCYONIUM EQUISETIFORME Lüttschwager.

A. paessleri MAY, Alcyon. Ergeb. Hamburg. Magulh. Sammelreise (1899).

A. equisetiforme LÜTTSCHWAGER, Philip. Journ. Sci. 20 (1922) 525.

Colony composed of a thick rounded stem that gives off a number of main branches. These in turn divide to form several rounded, fingerlike, pointed processes that are about 3 cm long. The long thick stem together with the strong branching on the upper portion gives a treelike impression in which the stem can be well distinguished with an upper crown. Polyps

present both on the branches and the upper portion of the stem. The sclerites are principally confined to the stem. Sclerites of stalk cœnenchyma are irregular cylinders, mostly 0.1 to 0.2 mm long and 0.06 mm wide, with more or less pointed ends with weak constriction at middle and very thickly warted. In the cœnenchyma of the branches there are few small sticks. The colony is hard and stiff below but rather soft and flabby at the upper parts.

Color in alcohol yellowish to brown.

Previously reported from Franklin Island. Philippine material obtained from Puerto Galera Bay, Mindoro.

Genus LOBOPHYTUM Marenzeller

Lobophytum MARENZELLER, Zool. Jahrb. Syst. 1 (1886) 341.
Lobophytum WRIGHT and STUDER, Challenger Report, Zool. 31 (1889) 250.
Lobophytum MAY, Mitteil. Mus. Hamburg. 15 (1898) 28.
Lobophytum PRATT, Alcyon. Maldives (1903) 514.
Lobophytum KÜKENTHAL, Abh. Mayer, Ak. 2 Suppl. Bd. 1 (1906) 20.
Lobophytum LÜTTSCHWAGER, Arch. Naturg. A Heft 10 (1914) 27.
Lobophytum J. MOSER, Mitteil. Mus. Berlin 9 (1919) 257.

The genus *Lobophytum,* with three species, was established by Marenzeller in 1886. Seventeen others species have been described as belonging to this genus. Six of the species do not belong to the genus. J. Moser (1919) examining recently collected material from the Philippines and other material in the Berlin Museum found three new species, bringing the total number of valid species and varieties of the genus to seventeen. Four of these are not encountered in the Philippines.

The members of the genus can be distinguished from other genera of the family Alcyoniidæ by the use of the following diagnosis: The disc, which is sharply delimited from the stalk by a distinct boundary, has a surface thrown up into lobes or fingerlike processes that are closed except for a slight triangular indentation at the base of those situated peripherally. The polyps are confined to the disc and its processes. These are small, closely set, fully retractile and with dimorphism. Sex cells are found only in the autozooids. Stomodeal walls wholly or almost entirely free of sclerites. Endodermal canal net not differentiated into an outer and inner part. The warts of the cœnenchymal sclerites are strongly inclined to form girdles.

To make the classification utilized in this section clear, I am showing here the systematic relationships of all species and

varieties heretofore described as belonging to the genus *Lobophytum.*

1. LOBOPHYTUM SARCOPHYTOIDES J. Moser.
2. LOBOPHYTUM BATARUM J. Moser.
3. LOBOPHYTUM SCHOEDEI J. Moser.
4. LOBOPHYTUM CREBRIPLICATUM Marenzeller.
5. LOBOPHYTUM CREBRIPLICATUM var. CRASSOSPICULATUM J. Moser.
   Lobophytum crassum var. *sansibaricum* May (part.).
6. LOBOPHYTUM GAZELLAE J. Moser.
   Lobophytum glaucum Th. Studer non Quoy and Gaimard.
7. LOBOPHYTUM ROXASI J. Moser MS.
8. LOBOPHYTUM CRASSUM Marenzeller.
   Lobophytum pauciflorum Pratt non Ehrenberg.
   Lobophytum crassum var. *australicum* May.
   Lobophytum crassum var. *proliferum* Marenzeller.
   Lobophytum crassum var. *sansibaricum* May (part.).
   Lobophytum murale (Dana).
   Lobophytum crassum var. *crista-galli* Marenzeller.
9. LOBOPHYTUM CRASSUM var. BORBONICUM Marenzeller.
10. LOBOPHYTUM HEDLEYI Whitelegge.
11. LOBOPHYTUM LIGHTI J. Moser.
12. LOBOPHYTUM PAUCIFLORUM (Ehrenberg).
    Lobophytum candelabrum Roule.
    Lobophytum madreporoides Ridley.
    Lobophytum rigidum May non Dana.
    Lobophytum submurale (Ridley).
    Lobophytum pauciflorum var. *validum* Marenzeller.
13. LOBOPHYTUM PAUCIFLORUM var. PHILIPPINENSE J. Moser.

Key to the species of the genus Lobophytum Marenzeller.

a^1. Stalk sclerites never with cylindrical or barrel-shaped forms.
  b^1. Folds and lobes not prominent, found only on disc periphery. *L. sarcophytoides* J. Moser.
  b^2. Disc fully covered with lobes........ *L. batarum* J. Moser.
a^2. Among basal stalk sclerites are cylindrical and barrel-like forms.
  b^1. Disc outer surface only with shallow corrugated lobes, not fingerlike processes.
    c^1. Colony low and broad.
      d^1. Lobes only on periphery........ *L. schoedei* J. Moser.
      d^2. Disc fully covered all over by lobes.
        e^1. Sclerites of stalk basis over 0.25 mm long. *L. crebriplicatum* Marenzeller.
        e^2. Sclerites of stalk basis less than 0.25 mm long. *L. crebriplicatum* var. *crassospiculatum* J. Moser.
    c^2. Colony slender and rather high........ *L. gazellae* J. Moser.
  b^2. Disc outer surface with lobes cleft into fingerlike processes.
    c^1. Lobes not cleft up to base such that disc may be partly covered with lobes and partly by fingerlike processes.

d^1. Lobes irregularly cleft.

e^1. Stalk base has spindles in addition to cylinders and barrels.
L. roxasi J. Moser.

e^2. Stalk without any spindlelike sclerites.

f^1. Disc sclerites more than 0.26 mm long.
L. crassum Marenzeller.

f^2. Disc sclerites at most 0.26 mm long.
L. crassum var. *borbonicum* Marenzeller.

d^2. Lobes very regularly cleft.

e^1. Lobes numerous, radially arranged, each with more than two processes .... *L. hedleyi* Whitelegge.

e^2. Lobes few, radially flattened, broad at ends and with processes.
L. lighti J. Moser.

c^2. Lobes cleft up to base into fingerlike process.

d^1. Sclerites of stalk base over 0.22 mm long.
L. pauciflorum (Ehrenberg).

d^2. Sclerites of stalk base less than 0.22 mm long.
L. pauciflorum var. *philippinense* J. Moser.

LOBOPHYTUM SARCOPHYTOIDES J. Moser.

L. sarcophytoides J. MOSER, Mitteil. Zool. Mus. Berlin **9** (1919) 267, fig. 13, pl. 6, fig. 16.

Disc provided with oak-leaf-like folds and lobes at periphery which may be fingerlike processes at middle. Autozooids small, closely set, with one row of siphonozooids between them. Stalk sclerites are sticks and spindles about 0.33 mm long 0.09 mm wide, with three to eight whorls of high warts.

Stalk slightly widened apically. Disc with numerous folds and lobes resembling oak leaves. Autozooids small, inconspicuous and closely set with only one row of siphonozooids between two of them at upper parts of lobes. Siphonozooids very small and almost invisible to naked eye. Sclerites of disc cortex are pointed spindles, 0.07 to 0.09 mm long with two rows of few low warts, and clubs about 0.1 mm long with warty heads. In stalk cortex are small clubs 0.11 mm long with warts better differentiated than in disc cortex clubs. In disc interior are spindles and sticks 0.25 to 0.38 mm long and 0.06 mm wide with widely separate low warts that are distinctly arranged in whorls. In stalk cœnenchyma are spindles on the average 0.25 mm long and 0.08 mm wide, covered with large or small warts arranged in more or less definite girdles. Few sticks reaching 0.38 mm long and 0.06 mm wide with less-differentiated warts are also present. Some stalk sclerites are sometimes curved or otherwise deformed.

Colonies large, largest known has disc 17 cm in diameter.

Reported only from the Philippines.

LOBOPHYTUM BATARUM J. Moser.

L. batarum J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 268, fig. 14; pl. 6, fig. 13.

Disc fully covered with numerous, radially directed, flattened, but high lobes that may often be divided. Autozooids small and extraordinarily closely set. Siphonozooids small. Stalk sclerites are long spindles, up to 0.52 mm long, with as many as nine whorls of warts.

Stalk high and conical. Disc fully covered with small, high, radially directed lobes. These are either undivided, corrugated, or divided into fingerlike processes whose cross sections are never circular. Only one row of small inconspicuous siphonozooids between two autozooids. Cortical sclerites are simple sticks and spindles 0.05 to 0.2 mm long, and clubs with warty heads which in stalk cortex are 0.12 mm long on the average. In disc cœnenchyma are simple sticks reaching 0.45 mm long with high undifferentiated warts. In stalk interior are spindles, on the average 0.4 mm long, whose slightly differentiated warts are arranged visibly into as many as ten whorls. Basal part of stalk full of similar but more-massive spindles that may reach a length of 0.5 mm.

Colonies large; the largest known has the disc 16 cm in diameter.

Reported only from the Philippines.

LOBOPHYTUM SCHOEDEI J. Moser.

Lobophytum schoedei J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 276, fig. 18; pl. 6, fig. 14.

Disc carries numerous, high, small, often corrugated, slightly differentiated lobes which extend from periphery towards center. Autozooids and siphonozooids small and very closely set. Sclerites of stalk interior are massive spindles and barrels about 0.3 mm long with six indistinct whorls of warts. Disc has cylindrical sclerites as long as 0.2 mm, approaching the appearance of spindles, and dumb-bell-shaped barrels with well-differentiated ends.

Reported from Bougainville; a non-Philippine species.

LOBOPHYTUM CREBRIPLICATUM Marenzeller.

Lobophytum crebriplicatum MARENZELLER, Zool. Jahrb. Syst. 1 (1886) 362, pl. 9, fig. 7.

Disc fully covered with low or high folds, about 5 mm thick, extending radially and whose apices are fully or partially folded,

which especially towards center of disc may give rise to conical processes. Autozooids far apart, about 2 mm from each other. Siphonozooids small, but not very closely set, and not deep-set. Disc cortical sclerites 0.2 to 0.24 mm long. Sclerites of disc interior are slender spindles 0.25 mm to 0.35 mm long and 0.05 to 0.07 mm wide with small warts. Sclerites of stalk cortex are small clubs. Those in stalk interior are warty spindles about 0.25 mm long and 0.07 to 0.08 mm wide.

Known only from Tonga Island; a non-Philippine species.

LOBOPHYTUM CREBRIPLICATUM var. CRASSOSPICULATUM J. Moser.

L. crebriplicatum MARENZELLER, Zool. Jahrb. Syst. 1 (1886) 362, pl. 9, fig. 7.

Disc fully covered with low lobes which may reach its center. Autozooids 1 to 2 mm apart. Siphonozooids in two rows between two autozooids. Stalk sclerites barrel-shaped or cylinders on the average 0.17 mm long and 0.1 mm wide with four distinct whorls of warts. Differs from typical species in having much smaller stalk sclerites.

Stalk carries a thick disc which is divided into low, stout, radially arranged, thickly set lobes which reach center. Top of lobes may be partly or fully divided and can give rise to conical processes at their central part. Autozooids tiny but distinct. On lobes there are usually two of them between two autozooids. Sclerites of disc cortex are thick spindles 0.12 to 0.19 mm long, with two whorls of small, undifferentiated warts, and clubs as long as 0.13 mm long with a warty head and a tiny wart ring at pointed end. In disc cœnenchyma are spindles on the average 0.27 mm long and as wide as 0.075 mm, and barrels about 0.21 mm long and almost 0.075 mm wide with closely set warts. Sclerites of stalk interior are barrels and cylinders 0.16 to 0.21 mm long and up to 0.12 mm wide with four wide whorls of warts. Few spindles about 0.32 mm long and 0.09 mm wide and oftentimes slightly bent are also found.

Colonies small, largest known has disc 9 cm in diameter.

Reported from Puerto Galera Bay, Mindoro, Philippines, and Zanzibar.

LOBOPHYTUM GAZELLAE J. Moser.

Sarcophytum glaucum STUDER, Monatsb. Ak. Wiss. Berlin (1878) 634.

Disc has several thick, high, but poorly differentiated lobes extending up to center, on which small closely set autozooids are found. Siphonozooids very small and indistinct. Stalk

sclerites are slender spindles, 0.25 mm long with six to eight whorls of warts, and cylinders on the average 0.2 mm long with four whorls of warts. Disc sclerites are spindles as long as 0.43 mm.

Disc distinctly delimited from cylindrical stalk. It has high, radially directed, massive, oftentimes waved, lobes. Autozooids small, closely set, there being about ten in a centimeter. Siphonozooids very small and indistinct. At apices of lobes there are two to three of them between two autozooids. Disc cortex with poorly differentiated sticks 0.05 to 0.3 mm long, and clubs on the average 0.16 mm long. Stalk cortex sclerites more massive and more differentiated, about 0.13 mm long and 0.06 mm wide. In disc cœnenchyma are massive spindles, clubs, and slender sticks, from 0.25 to 0.4 mm long. Stalk interior contains simple barrels about 0.15 mm long, well-differentiated massive barrels on the average 0.21 mm long with four distinct whorls of warts, and slender spindles as long as 0.3 mm with six to eight whorls of warts.

Colonies small, usually 3 cm in diameter.

Formerly known only from New Ireland. New material was obtained recently from Puerto Galera Bay, Mindoro, Philippines.

LOBOPHYTUM ROXASI J. Moser MS.

Disc with laterally flattened fingerlike lobes not regularly cleft up to bases. Lobes present on periphery as well as center of disc. Autozooids small, about 1 to 1.5 mm apart with two to three rows of very tiny siphonozooids between them. Stalk sclerites spindles as well as short stumpy barrels.

The colony has a short sterile stalk, marked with few irregular longitudinal lines on one side, from which the disc extends out peripherally only for a short distance. Disc composed of a periphery sharply delimited from the stalk, and six to eight lobes which are usually flattened radially. Four or five of these are peripheral and two or more are median. Autozooids small, and at the apices of lobes they are 1 to 1.5 mm apart with two to three rows of very tiny siphonozooids between them. Disc cortex is provided with small, almost smooth, pointed sticks about 0.14 mm long and 0.011 mm wide. Stalk cortex with small sticks similar to those of the disc but with few conical warts. Disc cœnenchyma provided with slender simple spindles, at most 0.37 mm long and 0.056 mm wide, with low truncated warts which at times are arranged to form about eight girdles.

In stalk cœnenchyma are similar spindles, at most 0.37 mm long and 0.056 mm wide, in addition to numerous short stout barrels about 0.2 mm long and 0.098 mm wide with about four more or less definite whorls of large warts. In addition there are a few almost spherical sclerites about 0.12 mm in diameter with irregular warts.

Moser's type in the Berlin Museum is a small colony with a stalk 18 mm high and 25 mm in largest diameter, and a disc 25 mm high and a large diameter of 40 mm. Its spiculation is similar to that of *L. gazellae,* although other characters are entirely different.

Locality: The exact Philippine locality is unknown.

LOBOPHYTUM CRASSUM Marenzeller.

Lobophytum crassum MARENZELLER, Zool. Jahrb. Syst. 1 (1886) 363.
Lobophytum crassum var. *crista-galli* MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 286, fig. 2–3.

Disc with rough, loose, irregularly cleft lobes. Autozooids small, hardly visible. Siphonozooids numerous but small. Stalk sclerites are barrels 0.17 to 0.2 mm long and as much as 0.1 mm wide with two to four whorls of warts. Cœnenchymal sclerites are spindles, 0.28 mm long on the average with distinct warts in girdles.

Stalk carries a large, rough disc with numerous closely set lobes. Edge of lobes may be deeply indented or only slightly roughened. Fingerlike processes are also not infrequent on periphery of disc. Autozooid and siphonozooids small, but visible. Sclerites of disc cortex slender, poorly differentiated spindles reaching 0.13 mm long with two widely separate whorls of low warts. In disc cœnenchyma, sclerites are stout spindles, oftentimes bent, 0.25 mm to 0.35 mm long and as much as 0.08 mm wide. In deeper portions of disc are cylinders 0.2 to 0.24 mm long and 0.1 mm wide. Warts are always in distinct whorls. In stalk cortex are sclerites similar to those in disc cortex although slightly longer and more differentiated. Besides, small clubs as long as 0.15 mm are also seen. Stalk interior has barrel-shaped sclerites on the average 0.17 mm long and almost half as wide with two to four whorls of tall warts.

Colonies very large; may measure as much as 100 cm in disc diameter.

Known from Reunion Island, Port Denison, Tonga Island, Mauritius, Loyalty Island, Pedro Shoal, Prasslin, Northeast Australia, Tamataves, East Africa, Zanzibar, and the Philippines.

LOBOPHYTUM CRASSUM var. BORBONICUM Marenzeller.

Lobophytum crassum var. *borbonicum* MARENZELLER, Zool. Jahrb. 1 (1886) 364.

This variety differs from the typical species in having shorter disc sclerites that never grow longer than 0.26 mm and in having stalk sclerites more or less like blackberries in shape.

The example from the Philippines was obtained from Taytay Bay and has a dimension of 16 cm high and 10 to 12 cm in diameter. This variety has also been reported from Reunion Island.

Lobophytum crassum var. *crista-galli* Marenz. should be included under the typical species.

LOBOPHYTUM HEDLEYI Whitelegge.

Lobophytum hedleyi WHITELEGGE, Mem. Austr. Mus. (1897) 217, pl. 10, fig. 2*a–b*.

Disc with high lobes divided into uniform fingerlike processes. Autozooids sparse; on top of lobes they are 1 to 2 mm apart. Stalk sclerites as large as 0.2 mm long and 0.1 mm wide.

Stalk carries a disc covered with seemingly high folds, which may still be divided into fingerlike processes. Autozooids not numerous, at upper portions of lobes they are 1 to 2 mm apart. Siphonozooids numerous and lie deep. Sclerites of disc cortex are small spindles about 0.11 mm long with widely separate whorls of small low warts. In stalk cortex are also spindles of stronger build about 0.13 mm long with as many as three whorls of small warts and with warty head. In disc interior are spindles 0.3 mm long with girdles of medium-size warts. Sclerites of stalk interior are stout spindles or barrels about 0.17 mm long and 0.1 mm wide. They always have four whorls of warts, the two median always being more prominent than the two terminal.

Colonies large, measuring as much as 50 cm in diameter.

Reported from Funafuti, Ceylon, Amboina, New Ireland, and the Philippines.

LOBOPHYTUM LIGHTI J. Moser.

Lobophytum lighti J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919).

Lobes of disc, which are two-pointed apically, become smaller and stalklike basally. Autozooids about 1 mm apart. Siphonozooids are not very small, deeply set, yet visible. Stalk sclerites are barrel-shaped and cylindrical 0.2 to 0.26 mm long and as wide as 0.14 mm, with two to four whorls of warts. Upper stalk has in addition sticks and spindles 0.2 to 0.5 mm long with well-developed warting.

Disc with flat, high lobes arranged tangentially with bases stalklike. Lobes, as a result of rounded invagination, become divided into two points which form either an acute or right angle with each other. Autozooids small, 1 to 5 mm apart. When expanded they are about 3 mm long. Siphonozooids large and prominent, closely set but not deep. Sclerites of disc cortex simple spindles about 0.11 mm long with two whorls of low undifferentiated warts. Disc cœnenchyma sclerites are spindles and clubs 0.25 to 0.38 mm long with many indistinct whorls of differentiated warts. Sclerites of upper stalk cortex are similar to those in the disc cortex. They are as long as 0.2 mm. At lower levels of stalk, cortical sclerites are massive spindles about 0.2 mm long or longer, with two to four whorls of warts. In stalk interior there are two kinds of skeletal formation. In the upper parts are slender sticks and spindles 0.5 mm long. The longer the sclerites, the less differentiated are the warts. In stalk base are cylindrical sclerites 0.25 mm long and as wide as 0.14 mm with prominent, rich, warting. The ends may be pointed or blunt. Besides, numerous spindles, almost as long but visibly narrower, with numerous well-developed warts in widely separate and distinct whorls, are also present.

Colonies not large; the one described by Moser has a diameter of 6.5 cm.

Reported only from the Philippines.

LOBOPHYTUM PAUCIFLORUM (Ehrenberg).

Lobularia pauciflorum EHRENBERG, Corallth. Roten Meeres (1834) 58.

Disc with separate processes usually divided up to their base. Autozooids about 2 mm apart. Siphonozooids tiny and thickly set. Stalk sclerites elongate barrels 0.2 to 0.26 mm long and up to 0.09 mm wide, with two to four whorls of warts. Disc sclerites are warted sticks and spindles 0.4 mm long and 0.1 mm wide.

Processes on disc fingerlike, separate and divided down to their bases. Besides, there are also some short, compressed, but separate lobes. Openings of autozooids large, about 2 mm apart on the processes. Siphonozooids small but visible, about five between two autozooids. Cortical sclerites of disc simple spindles about 0.12 mm long. In disc interior are slender spindles usually 0.28 mm, but sometimes 0.4 mm long, and at most 0.1 mm wide, richly covered with girdles of high warts. Sclerites of stalk cortex are similar to those of disc cortex but slightly

longer and stronger in build. In stalk interior are barrel-shaped sclerites 0.22 to 0.26 mm long with four to six distinct rings of large warts.

Colonies usually large with disc reaching 30 cm in diameter.

Reported from Red Sea, Talili Bay, Andaman Island, Tonga, New Britain, Amboina, New Zealand, Moluccas, Funafuti, Maldives, Celebes, Wright Bank, and Philippines.

LOBOPHYTUM PAUCIFLORUM var. PHILIPPINENSE J. Moser.

Lobophytum pauciflorum var. *philippinensis* J. MOSER, Mitteil. Zool. Mus. Berlin **9** (1919) 281, fig. 21.

In this variety, the few deep divisions of fingerlike processes of disc are absent, so that lobes are visible here and there. This form has much smaller stalk sclerites than the typical species, reaching only a maximum length of 0.22 mm.

Disc covered with rounded fingerlike processes, which arise partly from seemingly high, radially arranged lobes. Autozooids large and black. Size and distance of siphonozooids similar to typical species. Sclerites of cortex as in typical form. In disc cortex are thickly warted spindles 0.24 mm long on the average, which may be at times more heavily warted on one side, making the sclerites appear cylindrical on this side. Wart whorls not distinct. In stalk cœnenchyma are barrels and cylinders 0.14 to 0.21 mm long and not quite half as wide, with four or more distinct whorls of warts. Usually they are pointed at both ends. Sometimes spindles up to 0.35 mm long with numerous warts are also seen.

Colonies not large, the largest known has the disc 8 cm in diameter.

Known only from Red Sea and Palawan, Philippines. *Lobophytum pauciflorum* var. *validum* Marenzeller should be included with the typical species.

Genus SARCOPHYTON Lesson emend. Marenzeller

Sarcophyton Lesson, BELANGER, Voy. Ind. Orient. Zool. Zooph. (1834) 517; DUBERREY, Voy. Coquille, Zool. 1830–38, II, Zooph. (1834) 92.

Sarcophytum MARENZELLER, Zool. Jahrb. Syst. **1** (1886) 341.

Sarcophytum KÜKENTHAL, Alcyon., Michaelsen u. Hartmeyer, Fauna Sudwest-Austral. **1** (1910) 6.

Sarcophytum KÜKENTHAL, Alcyon. Aru-Keiinseln, H. Merton, Erg. Zool. Forschungsreise in d. s.-o. Molukken, Erg. Senckenb Ges. **33** (1910) 309.

Sarcophyton J. MOSER, Mitteil. Zool. Mus. Berlin **9** (1919) 221.

The genus *Sarcophyton* was first established by Lesson in 1834 when he described an alcyonarian that he called *Sarcophyton lobulatum*. He was, however, unaware of the dimorphism of the polyps, and it was Kölliker (1867) who showed the existence of the nonsexual polyps. To the latter, Moseley (1880) gave the name "siphonozooids." The first comprehensive work on the genus was that of Marenzeller (1886) under the title "Über die *Sarcophytum* benannten Alcyoniiden." This work was much later improved upon by Kükenthal (1910) in his work on Alcyonaria of southwest Australia. The most recent and the most up-to-date treatise on the genus is that of Johannes Moser (1919), whose revision of the group grew out of the examination of alcyonarian material from the Philippines. Through his work much confusion was removed and now the group can easily be handled and studied even by workers who are not specialists. His paper was largely drawn upon in the preparation of this part of my work.

The genus *Sarcophyton* may, to a beginner, be mistaken for one of four other genera of the family Alcyoniidæ; namely, *Lobophytum, Sinularia, Alcyonium,* and *Anthomastus*. It can be easily distinguished, however, from *Lobophytum* by the fact that its folds or disc processes arise principally from the periphery. If lobes are present, they are laterally opened and are not as in *Lobophytum,* where the lobes or processes are entirely closed except for a slight, more or less triangular opening or indentation at the external sides of basal parts of lateral processes and where these processes are also found at the middle portions of the disc. Also in *Lobophytum* the warts of the sclerites have a greater tendency to form complete girdles or whorls, a phenomenon seldom seen in *Sarcophyton*. These two genera, however, are similar in having a distinct boundary line between the sterile stalk and the polyp-bearing disc or capitulum. *Sinularia* differs from *Sarcophyton* by the very long fingerlike processes of the disc and by the absence of a line of demarcation between the stalk and the distal portion of the colony. If a rimlike edge is present in *Sinularia* it does not separate the polyp-bearing portion of the colony from the sterile stalk. Members of the genus *Sinularia* always have very large stalk sclerites, usually longer than 2 mm. The genus *Alcyonium,* although very variable, can be recognized by the lack of siphonozooids, by the characteristic barrel-shaped sclerites (Doppelkeulen) in

the cœnenchyma, and by the characteristic growth of the disc. *Alcyonium* always has much smaller stalk sclerites than *Sinularia*. Finally in *Anthomastus* the disc is usually more or less spherical and it carries polyps on the upper as well as on the lower surface, and the gonads are found in the siphonozooids and not in the autozooids.

We shall, therefore, give the following diagnosis for the genus *Sarcophyton:*

Colony mushroom-shaped with the disc lobed or folded more or less strongly at margin, and set off distinctly from stalk. Polyps found only on outer disc surface; they are small, closely set, fully retractile, and dimorphic. Sex cells produced only in autozooids. Stomodeal wall almost or entirely free of sclerites. Endodermal canal net not differentiated into inner and outer parts. Cortical sclerites of disc and stalk are small clubs and short slender sticks. In disc cœnenchyma are longer, slender sticks and spindles more or less covered with warts. In stalk cœnenchyma are thin or very thick spindles, double spindles, or cylindrical sclerites covered with large warts.

In the latest work of Thomson and Dean, on the Alcyonacea of the Siboga Expedition, the authors reported having nine species of *Sarcophyton* in the collection, four of which were identified as new. Apparently these workers had not seen the work of J. Moser (1913). Upon examining their descriptions and illustrations, I found that their *S. trocheliophorum minus* n. var. is identical with *S. crassocaule* J. Moser, that *S. convolutum* Thomson and Dean is a form of *S. acutangulum,* and that *S. spongiosum* is the same as *S. latum* var. *voeltzkowi* J. Moser. As previously discussed by Moser, *S. gracile* of Burchardt is, of course, identical with *S. glaucum* (Quoy and Gaimard). *Sarcophyton tenuispiculatum* of Thomson and Dean appears to be a valid species if it is a *Sarcophyton.* The lone animal they described, however, is apparently young, and it is very probable that it is a young example of a *Lobophytum;* they based the determination on the spicules alone. If such is the case, then it is most probably identical with *Lobophytum sarcophytoides* J. Moser.

Those who have not seen Moser's paper on *Sarcophyton* can see in the following list where all previously described species and varieties of *Sarcophyton* rightly belong:

1. SARCOPHYTON LATUM (Dana).
2. SARCOPHYTON LATUM var. VOELTZKOWI J. Moser.
   Sarcophyton spongiosum Thomson and Dean.
3. SARCOPHYTON EHRENBERGI Marenzeller.
   Sarcophyton oligometra Pratt.
   Sarcophyton tenuis Pratt.
   Sarcophyton ehrenbergi var. *areolatum* Burchardt.
   Sarcophyton ehrenbergi var. *sansibaricum* May.
4. SARCOPHYTON EHRENBERGI var. STELLATUM Kükenthal.
5. SARCOPHYTON CRASSOCAULE J. Moser.
   Sarcophyton trocheliophorum var. *minus* Thomson and Dean.
6. SARCOPHYTON ACUTANGULUM (Marenzeller).
   Sarcophyton contortum Pratt.
   Sarcophyton roseum Pratt.
   Sarcophyton convolutum Thomson and Dean.
7. SARCOPHYTON PUERTO-GALERÆ Roxas.
8. SARCOPHYTON MOSERI Roxas.
9. SARCOPHYTON TROCHELIOPHORUM (Marenzeller).
   Sarcophyton dispersum Schenk.
   Sarcophyton pallidum Cohn.
   Sarcophyton pulmo Klunzinger.
   Sarcophyton reichenbachi Schenk.
   Sarcophyton viride (Thomson and Henderson).
   Sarcophyton trocheliophorum amboinense Marenzeller.
   Sarcophyton trocheliophorum var. *intermedium* Burchardt.
   Sarcophyton trocheliophorum var. *moluccanum* Schenk.
10. SARCOPHYTON DIGITATUM J. Moser.
11. SARCOPHYTON ELEGANS J. Moser.
12. SARCOPHYTON GLAUCUM (Quoy and Gaimard).
    Sarcophyton ambiguum Studer and Wright.
    Sarcophyton boettgeri Schenk.
    Sarcophyton flavum (Ruppell).
    Sarcophyton fungiforme Schenk.
    Sarcophyton gracile Burchardt.
    Sarcophyton mycetoides Gravier.
    Sarcophyton nigrum May.
    Sarcophyton philippinense Studer and Wright.
    Sarcophyton plicatum Schenk.
    Sarcophyton tongatabuense Studer and Wright.
    Sarcophyton glaucum var. *amboinense* Burchardt.
    Sarcophyton glaucum var. *pauperculum* Marenzeller.

Of the above valid species and varieties only two varieties (*S. latum* var. *voeltzkowi* and *S. ehrenbergi* var. *stellatum*) have not been reported from the Philippines. Two species, *S. digitatum* and *S. elegans*, have been reported only from the Philippines, and *S. crassocaule* of J. Moser was established primarily

from materials collected from Philippine waters. Thorpe (1928) recently described two forms of *Sarcophyton* as new varieties, *S. trocheliophorum* var. *australiensis* and *S. acutangulum* var. *occidentalis.* As these agree very closely with the typical species in habit and skeletal formation and differ from them only in a few minor details, it is probably best to allow these to remain in the type species and not establish new varieties. After a thorough study of the representatives of the genus *Sarcophyton,* I was compelled to add two new species to the twelve valid species of the genus; namely, *S. moseri* and *S. puerto-galeræ* (Roxas, 1932). Since then, I have found another new form, *S. tersum,* which is described here for the first time.

Key to the Philippine species of the genus Sarcophyton.

*a*¹. Disc not or only slightly projecting out of the upper portion of stalk.
- *b*¹. Stalk sclerites 0.4 mm or longer........................ *S. latum* (Dana).
- *b*². Stalk sclerites less than 0.4 mm long.
  - *c*¹. Disc thick, not or only slightly folded.
    - *d*¹. Warts of sclerites weak and indistinct............ *S. tersum* sp. nov.
    - *d*². Warts of sclerites prominent.
      - *e*¹. Stalk sclerites sticks or spindles.... *S. ehrenbergi* Marenzeller.
      - *e*². Stalk sclerites barrel-shaped or cylindrical or double stars.
        - *f*¹. Autozooids very large and prominent. *S. crassocaule* J. Moser.
        - *f*². Autozooids very small and inconspicuous. *S. puerto-galeræ* Roxas.
  - *c*². Disc thin, with folds very prominent.
    - *d*¹. Autozooids far apart; four to six siphonozooids between two of them; many secondary folds present. *S. acutangulum* (Marenzeller).
    - *d*². Autozooids closely set; one to two siphonozooids between two of them; few secondary folds........................ *S. moseri* Roxas.

*a*². Disc projecting far out of the stalk.
- *b*¹. Stalk sclerites double spindles and barrels. *S. trocheliophorum* (Marenzeller).
- *b*². Stalk sclerites sticks and spindles.
  - *c*¹. Disc with regular peripheral folds.
    - *d*¹. Marginal folds or lobes longer than broad.. *S. digitatum* J. Moser.
    - *d*². Marginal lobes not longer than broad........ *S. elegans* J. Moser.
  - *c*². Disc with irregular folds............ *S. glaucum* (Quoy and Gaimard).

SARCOPHYTON LATUM (Dana). Plate 1, fig. 1.

Alcyonium latum DANA, Zoophytes (1846) 623, pl. 58, figs.
Sarcophytum latum WHITELEGGE, Alcyon. Funafuti 1 (1897) 215.

Disc poorly differentiated, extending out only slightly if at all from a very wide funnel-shaped stalk. Only one row of

siphonozooids between the autozooids. Sclerites of stalk bases are spindles 0.4 mm long or longer.

Disc not or only folded at periphery and not or only slightly extending beyond circumference of stalk. Colony may be encrusting. Autozooids about 1 mm apart. Each is surrounded by a circle of ten siphonozooids and there is only one row of these between two autozooids. Sclerites of disc cortex are clubs about 0.13 mm long sparsely warted throughout their lengths, and spindles 0.08 to 0.25 mm long, often deformed with high but undifferentiated rounded warts. In disc interior sclerites are sticks and spindles over 0.4 mm long with warts less differentiated. In stalk cortex are clubs similar to those in cortex, in addition to spindles 0.5 mm long and over 0.1 mm thick, covered with big warts. Stalk interior full of similar but larger, stouter, and more-compact spindles which may reach 1 mm in length at base.

Colonies small; largest known has a disc diameter of 5 cm.

Reported from the Philippines, Madagascar, Australia, and Fiji Islands. Philippine material was obtained from Taytay Bay, Palawan.

SARCOPHYTON TERSUM sp. nov. Plate 1, fig. 2.

Disc thick, hardly projecting out of a very smooth stout stalk. Autozooids small, inconspicuous, with three to five tiny hardly visible siphonozooids between them. Stalk sclerites are weak-looking spindles with rounded ends and with low flat warts which may be arranged in definite whorls.

Disc thick and smooth, hardly exhibiting any folding and hardly projecting beyond the periphery of stalk. Stalk very smooth and slimy to touch, usually slightly tapering towards the point of attachment. Autozooids very small and inconspicuous, about 1 mm apart at center of disc. Siphonozooids very tiny, closely set, there being three to four of them between two autozooids. In cortex of disc are very weak-looking, flattened spindles 0.35 to 0.4 mm long and 0.04 mm wide, with very few, low, weak warts. In disc interior are slender, weak sticks 0.5 to 0.55 mm long and 0.04 to 0.07 mm wide which are almost devoid of warts. If these are present, they are low, widely separate, and weakly pointed. In stalk cortex are very weak sticks, about 0.25 mm long and 0.08 mm wide, nearly spindle-shaped but without definite wartings. In stalk cœnenchyma are stout spindles about 0.3 mm long and 0.1 mm wide with rounded ends and with low flat warts arranged in four to six definite whorls.

The shape of the colony approaches that of *S. crassocaule.* The weak warts arranged in whorls of the cœnenchymal sclerites and the smooth and slimy touch of the stalk and capitulum are, however, very characteristic of the species. Of all the species of *Sarcophyton,* this one possesses the least-developed warts on the sclerites.

This description is based on seven specimens (C–5003) all collected from Puerto Galera Bay, Mindoro. The largest is about 50 mm high, with a capitulum diameter of 55 mm and a stalk diameter of 40 mm. The smallest is 30 mm high with disc diameter of 32 mm and a stalk diameter of 20 mm. All, except the smallest, are sexually mature.

SARCOPHYTON EHRENBERGI Marenzeller. Plate 1, fig 3.

Sarcophytum ehrenbergi MARENZELLER, Zool. Jahrb. Syst. (1886) 356, pl. 9, figs. 3, 4.

Disc that does not extend out of the stalk level shows distinct folding at the periphery only. Center of disc cup-shaped. There are six to seven siphonozooids between two adjoining autozooids. The stalk sclerites are slender spindles and sticks about 0.25 mm long.

Disc cup-shaped and folded at the periphery, not projecting beyond the slightly constricted upper portion of stalk. Autozooids 1 to 1.5 mm apart; between two of them are three, small, inconspicuous siphonozooids. Sclerites of disc cortex are sticks 0.1 to 0.2 mm long with thorny heads. In interior of disc are slender sticks as long as 0.44 mm with high thorns and warts which may grow like horns. In addition, shorter but thicker spindles may be found. Sclerites of the stalk cortex are similar to those of the disc cortex although they are more massive. Stalk interior is full of spindles about 0.26 mm long with few, rough, coarse warts. Few spindles approaching cylinders found. Colonies not very large. Largest reported has a disc diameter of 12 cm.

Reported from the Red Sea, Maldives, Ceylon, Zanzibar, Philippines, Port Denison, Reunion, and Bismarck Archipelago. Philippine material obtained from Puerto Galera Bay, Mindoro.

SARCOPHYTON EHRENBERGI var. STELLATUM Kükenthal.

Sarcophytum ehrenbergi var. *stellatum* KÜKENTHAL, Alcyonaria, in Michaelsen and Hartmeyer, Fauna Sudwest-Austral. 3 (1910) 24.

This differs from the typical species in having nine to ten siphonozooids between two autozooids. The cortical sclerites

when seen from above appear star-shaped. Stalk sclerites are plates and double stars about 0.24 mm long.

Stalk short and slightly broadened apically. Disc thick, soft, and flat, thinner at periphery and not extending far out of stalk. It is folded into thick simple folds. Autozooids as high as 3 mm; thickly set at periphery, while at center they are 4 to 5 mm apart. Siphonozooids closely set, there being nine to ten between two autozooids. Sclerites of disc cortex are clubs, 0.09 to 0.12 mm long, with few processes. Few larger sparsely warted spindles are found among them. These spindles grow much longer and more slender in disc interior. They may be slightly arched and may reach a length of 0.24 mm. Mouths of siphonozooids appear wreathlike; they are full of perpendicular clubs and spindles, which appear as star-shaped sclerites about 0.03 mm in diameter with few, plump, rounded rays. In stalk interior are wide or narrow spindlelike sclerites 0.24 mm long covered with large irregularly placed warts.

Reported from the Aru Islands; non-Philippine.

SARCOPHYTON CRASSOCAULE J. Moser. Plate 1, fig. 4.

Sarcophyton crassocaule J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 243, fig. 6; pl. 5, fig. 10.

The disc, which is hardly folded, extends only slightly, if at all, over the general surface of the fat stalk. There are four to five siphonozooids between two autozooids. The stalk sclerites are cylinders and double spindles about 0.17 mm long. The warts are arranged in four incomplete girdles.

Disc not or hardly extending beyond stalk, only weakly folded, if at all, at periphery. Autozooids thickly set, about seven to ten for a distance of 1 cm. Siphonozooids small, five to six between two autozooids at center and only one to three at periphery. Sclerites of disc cortex simple spindles 0.07 to 0.18 mm long. Deformed and abnormal sclerites are present. In disc interior are spindles and sticks about 0.2 mm long whose warts are almost arranged into whorls mostly four in number. In stalk cortex are spindles and clubs 0.09 to 0.13 mm long, and barrels and double spindles about 0.17 mm long, whose weakly differentiated warts form two, sometimes four, whorls. Some malformed ones, among which are flat sclerites pointed at one end also present. Stalk cœnenchyma full of simple cylinders at most 0.2 mm long, and spindles of same length with four whorls of warts. Few, indefinite, spherical sclerites with undifferentiated warts also present. In stalk base are sclerites similar to

usual stalk sclerites but with well-differentiated and high warts arranged in whorls.

Colonies small; the largest known has a disc diameter of 9 cm.

Reported only from the Philippines, Liebliche Islands, and New Guinea. Philippine material from Palawan and Mindoro.

SARCOPHYTON PUERTO-GALERÆ Roxas. Plate 1, fig. 5.

Sarcophyton puerto-galerae ROXAS, Univ. Philip. Nat. Applied Sci. Bull. 4 No. 1 (1932) 78, figs. *1a–1d*.

The disc, which projects only slightly from the short stalk, has few peripheral thick folds and one or two low shallow lobes directed centrally. There are two to five very small siphonozooids between two autozooids. The stalk sclerites are barrels and double spindles, about 0.2 mm long and 0.1 mm wide with four more or less definite whorls of warts.

Disc projects only slightly from stalk and has shallow low peripheral folds, two or three of which have a tendency to become lobes which are directed into center of disc. Stalk itself low and wide, about 1.5 cm high and 2.5 cm in greatest diameter. Primary folds of disc weakly or not divided into secondaries. Autozooids very small and far apart with two to five very small siphonozooids, almost obsolete, between two of them. Sclerites of disc cortex are small clubs 0.1 to 0.13 mm long and 0.02 mm wide with small irregular warts. In disc interior are slender spindles 0.2 to 0.42 mm long and 0.03 to 0.04 mm wide with irregularly placed, small, pointed warts. Stalk cortex provided with small clubs 0.14 to 0.27 mm long and 0.03 to 0.05 mm wide, also with fine, irregularly placed warts. Stalk interior with barrel-shaped sclerites or double spindles with four more or less definite whorls of warts. They are 0.16 to 0.23 mm long and 0.096 mm wide. In addition to barrels and double spindles are almost spherical undifferentiated sclerites with low rounded warts. They are 0.1 to 0.11 mm long and 0.1 to 0.13 mm wide. Spindles 0.28 to 0.4 mm long, provided with small pointed warts arranged into six to ten irregular girdles are also seen in the stalk.

Locality: Puerto Galera Bay, Mindoro, Philippines.

Type in the University of the Philippines zoölogical collection; cotype in the Zoölogical Museum, Berlin.

The only species with which this may be confused, through its external appearance, is *S. crassocaule*. It differs from the

latter, however, in having its disc more folded and projecting farther out of the stalk. In *S. crasssocaule* the disc shows no lobes with tendency to become central, and its zooids are very much larger and easily visible. In skeletal composition it approaches *S. trocheliophorum,* although this never exhibits the almost spherical sclerites found in the stalk.

Colonies are small, the largest known has a disc diameter of 5 cm.

SARCOPHYTON ACUTANGULUM (Marenzeller).

Sarcophytum ehrenbergi var. *acutangulum* MARENZELLER, Jahrb. Syst. 1 (1886) 357.

Sarcophytum roseum PRATT, Alcyon. Maldives 2 (1903) 512, pl. 29, figs. 10, 11.

Sarcophytum contortum PRATT, Alcyon., Ceylon Pearl Oyster Fish. Rep. Suppl. Rep. 19 (1905) 251, pl. 1, figs. 6, 7.

Sarcophytum acutangulum KÜKENTHAL, Alcyonaria in Michaelsen and Hartmeyer, Fauna Sudwest-Austral. 3 (1910) 25, pl. 2, figs. 10, 11.

Sarcophyton a. J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 244, fig. 7.

Sarcophytum a. var. *occidentalis* THORPE, Journ. Linnean Soc. 36 (1928) 502.

The disc, which projects only slightly from the stalk, is folded into primary and secondary high folds resembling an oak leaf. There are three to six siphonozooids between two autozooids. The stalk sclerites are sticks and spindles about 0.36 mm long with wart girdles.

Disc strongly and regularly folded and extends only slightly from a somewhat broadened stalk. Primary disc folds are again folded into secondaries so that folds have oak-leaf forms. Autozooids at center of disc about 4 mm apart, but at periphery they are so close that no siphonozooids are seen between them. At folds near center of disc there are four to six siphonozooids between two autozooids. Sclerites of disc cortex are clubs about 0.08 to 0.1 mm long. In disc interior are spindles 0.2 mm long and sticks 0.3 mm long whose warts are strongly arranged into whorls. In stalk cortex are clubs similar to those of disc cortex but slightly larger. Sclerites of stalk interior are sticks usually 0.33 mm long but reaching 0.45 mm, and spindles 0.3 mm long. Warts of stalk sclerites approach a whorllike arrangement.

Colonies not very large; the largest known has a disc diameter of 18 cm.

274369——3

Reported from the Philippines, Red Sea, Maldives, Ceylon, northwestern Australia, Port Denison, Tonga Islands, and Viti Islands. Philippine material is from Palawan.

SARCOPHYTON MOSERI Roxas. Plate 1, fig. 6.

Sarcophyton moseri ROXAS, Univ. Philip. Nat. Applied Sci. Bull. 4 No. 1 (1932) 80, figs. *2a–2e*.

The disc, which projects only slightly from the stalk, has primary and secondary folds. There is only one row of siphonozooids between two autozooids. Stalk sclerites are spindles about 0.26 mm long with irregularly placed warts.

Stalk slightly flattened, 3.5 cm high and 4 cm in long diameter. Disc projects only slightly over the slightly broadened apical portion of stalk. Disc has a hollow center and a thin periphery which is divided into seven peripheral folds. Two or three of these are again divided into more or less deep secondaries. Autozooids small and closely set, about 0.5 mm apart, which toward the periphery may still be less. There is usually only one row of siphonozooids between two autozooids, although towards the center there may be two. Sclerites of disc surface are small clubs 0.1 to 1.4 mm long and 0.02 to 0.04 mm wide with well-developed heads. In disc interior are small sticks, at most 0.15 to 0.20 mm long and 0.03 to 0.04 mm wide with irregularly arranged warts. Sclerites of stalk cortex are few small clubs or sticks, 0.07 to 0.1 mm long and 0.02 to 0.03 mm wide, with few warts. A few sclerites are larger and approach those of the stalk interior in form. The latter are larger spindles, 0.20 mm to 0.29 mm long and 0.05 to 0.06 mm wide, with small, irregularly placed warts. Four-rayed sclerites are also found among these spindles.

Locality: Puerto Galera Bay, Mindoro, Philippines.

Type in the University of the Philippines zoölogical collection, Manila.

Sarcophyton moseri is more or less intermediate between *S. ehrenbergi* and *S. acutangulum* in external appearance. In the former the disc periphery has shallow peripheral folds which are not divided into secondaries. In the latter, the peripheral folds are so thorough and deep, with very many secondary folds, that they appear like oak leaves. In skeletal structures, *S. moseri* is intermediate between *S. acutangulum* and *Lobophytum sarcophytoides*. Although a *Sarcophyton*, its sclerites approach those of the latter much closer. Unlike these, however, the

spindles are more pointed and the warts are less prominent and not very regularly arranged to form girdles which are typical of the genus *Lobophytum.* The disc sclerites are also smaller, at most 0.2 mm long, as compared with *L. sarcophytoides,* in which they are from 0.25 to 0.38 mm long. The stalk sclerites of this species can easily be distinguished from those of *S. acutangulum* as they are much broader.

Colonies are not very large; the one described here has a disc diameter of 7 cm.

SARCOPHYTON TROCHELIOPHORUM (Marenzeller). Plate 1, fig. 7.

Sarcophyton trocheliophorum J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 246, figs. 8, 9. (See this for complete synonymy.)

Sarcophytum t. var. *australiensis* THORPE, Journ. Linn. Soc. 36 (1928) 500.

The disc projects far out of the stalk and is much folded at periphery, the folds, at places, becoming fingerlike processes. Between two autozooids eight to ten siphonozooids are found. The stalk sclerites are double spindles, barrel-shaped or blackberry-shaped, on the average 0.2 to 0.3 mm long with two to four whorls of warts.

Disc extends far out of stalk and is folded strongly at periphery. Folds may also become fingerlike processes as a result of growth of periphery of disc. Autozooids 1 to 3 mm apart with about nine siphonozooids between two of them at middle of disc. Cortical sclerites of disc and stalk are small clubs as long as 0.2 mm and somewhat longer, thin sticks. In addition strong, wide spindles, double spindles, and barrel-shaped sclerites are found in stalk cortex. Sclerites of disc interior are sticks 0.5 mm long on the average, usually with fine warts, if present at all. Stalk interior full of wide, stout double spindles and clubs on the average 0.25 mm long (may reach 0.5 mm) covered with pointed thorny warts arranged in two to four whorls. In addition one may find more or less frequently citron- or walnut-shaped sclerites reaching 0.5 mm long.

Colonies are very large; the largest described has a disc diameter of 120 cm.

Reported from Red Sea, Madagascar, Maldives, Ceylon, Philippines, Zanzibar, Western Australia, Sumatra, and tropical west Pacific Ocean. Philippine material obtained from Palawan and Mindoro.

SARCOPHYTON DIGITATUM J. Moser. Plate 1, fig. 8.

Sarcophyton digitatum J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 249, fig. 10; pl. 5, fig. 8.

The disc, which projects far out of the stalk, is not folded at the middle, but drawn at the periphery into long narrow lobes as a result of strong outward folding of the edge. There are seven to eight siphonozooids between two autozooids. The stalk sclerites are thin sticks and slender spindles up to 0.75 mm long.

Smooth cylindrical stalk carries a thin, soft, elastic disc drawn at periphery into fingerlike folds, which bear polyps on outer surface only. Autozooids 5 mm long, 1 to 2 mm apart at edge of disc and 3 to 5 mm at center. Siphonozooids with polyhedral mouth openings, three to eight between two autozooids. Sclerites of stalk and disc cortex very few. These are short sticks with few, small, but pointed warts. In disc cortex they are 0.05 to 0.19 mm long and 0.01 to 0.03 mm wide. At disc periphery cortical sclerites are longer but thinner than at center. Disc interior has sticks 0.08 to 0.35 mm long and 0.01 to 0.05 mm thick, often bent. Stalk cortex with similar sclerites reaching 0.02 mm long and 0.04 mm thick, in addition to spindles 0.3 mm long and 0.15 mm thick with variable warting. In stalk cœnenchyma are sticks 0.2 to 0.75 mm long and 0.03 to 0.08 mm thick, more or less covered with small warts, which oftentimes may be completely absent. Usually they are bent to one side or S-shaped. In addition, clubs 0.15 to 0.4 mm long and 0.05 mm to 0.1 mm thick and spindles at most 0.2 mm long and usually 0.09 mm thick, are found.

Colonies small, largest known has a disc diameter of 7.5 cm, processes included.

Reported only from Puerto Galera Bay, Mindoro, Philippines.

SARCOPHYTON ELEGANS J. Moser. Plate 1, fig. 9.

Sarcophyton elegans J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 252, fig. 11; pl. 5, fig. 9.

The stalk is flask-shaped and the disc, as a result of the ingrowth of certain parts of the rim, has peripheral open folds that are broad basally and narrow apically. There are about twelve siphonozooids between two autozooids. The stalk sclerites are spindles up to 0.5 mm long.

Stalk flash-shaped and disc with peripheral folds wide at base and narrow at apex. Autozooids 2 to 5 mm apart. Siphonozooids very small, five to twelve between two autozooids, their edges not touching each other, but fully covering the entire elevated portions of the disc where autozooids are located. Sclerites of disc cortex are sticks 0.06 to 0.4 mm long and 0.008 to 0.04 mm wide, slightly bent and covered with pointed warts. Sclerites of indefinite forms reaching 0.38 mm long and 0.09 mm wide and covered with high thorny warts are also present, in addition to clubs about 0.07 mm long. Sclerites of disc edge are longer and stronger and have larger warts. In stalk cortex there are similar but more massively built sclerites. Sclerites of disc interior are similar to those of cortex. In stalk cœnenchyma are deformed spindles up to 0.55 mm in length with high and stumpy warts.

Colonies small, the largest known has a disc diameter of 5 cm.

Reported only from the Philippines, Puerto Galera Bay, Mindoro, in water 13 to 25 meters deep.

SARCOPHYTON GLAUCUM (Quoy and Gaimard). Plate 1, fig. 10.

Alcyonium glaucum QUOY and GAIMARD, Voy. Astrolabe 4 (1833) Zooph. 270, pl. 22, figs. 11, 12.

Sarcophyton glaucum J. MOSER, Mitteil. Zool. Mus. Berlin 9 (1919) 253, fig. 12. (See this for complete synonymy.)

The disc that projects far out of the stalk has numerous long folds. There are four to nine siphonozooids between two autozooids. The stalk sclerites are large spindles 0.5 to 2 mm long.

Stalk carries a disc divided into primary and secondary folds that extend up to middle. Autozooids 2 to 5 mm apart, with four to nine small but clearly visible siphonozooids between them. Sclerites of disc and stalk cortex are small clubs and sparsely warted sticks which reach a length of 0.3 mm. In disc interior there are also sticks up to 0.4 mm long. In stalk there are spindles on the average 0.8 mm long that are heavily warted. In many specimens these spindles may reach 2 mm in length, and may be deformed in various ways.

Colonies are large, the largest known has a disc diameter of 1 meter.

Reported from Tonga Islands, Australia, Amboina, East Africa, Maldives, Red Sea, and Philippines. Philippine material ob-

tained from Palawan, Butu Island, Mataguit Island, Shark's Bay, Taytay Bay, and Puerto Galera Bay, Mindoro.

Family NEPHTHYIDÆ Verrill

Nephthyidæ VERRILL, Proc. Essex Inst. 6 (1869).

Spoggodidæ, Nephthyadea, Lemnaliadae GRAY, Ann. & Mag. Nat. Hist. IV 3 (1869) 128–130.

Alcyoniinæ capituliferae KLUNZINGER, Die Korallthiere des Rothen Meeres Theil 1 (1877) 30.

Nephthyidæ + *Siphonogorgiaceae* WRIGHT and STUDER, Rep. Challenger Report 31 (1889) 188f.

Nephthyidæ HOLM, Zool. Jahrb. 8 Syst. (1895) 11f.

Nephthyidæ KÜKENTHAL, Abh. Senkenb. Ges. Frankfurt 23 (1896) 86–88, 134.

Of all the families of Alcyonacea, the Nephthyidæ is probably the hardest to classify. This is mainly due to the enormous number of species under it and the very little differences existing between the various genera. I shall not review the history of the family as this has been done many times by other workers. Suffice it to say that Kükenthal in his revision of the family in 1903 included under it eight genera; namely, *Litophyton, Eunephthya, Capnella, Lemnalia, Scleronephthya, Nephthya, Spongodes*, and *Neospongodes*. Before this revision was fully completed in 1907, Kükenthal had revived the genus *Gersamia* of Marenzeller, and divided the old genus *Spongodes* into *Dendronephthya* and *Stereonephthya*. In 1913, Kükenthal created the genus *Paralemnalia* on the validity of which I have later more to say. Finally, in 1914, Light established the new genus *Lemnalioides*, bringing the number of genera within the family to twelve. Of the above-named genera of Nephthyidæ, three are not found in Philippine waters. Representatives of *Eunephthya* are almost all Arctic forms, confined for the most part to the northern European coast; only two species have been reported from Japan and one species from the Antarctic. The various species of the genus *Gersamia* are confined to the north Atlantic, while those of *Neospongodes* are to be met only along the east coast of tropical South America.

Key to the genera of the family Nephthyidæ.

*a*¹. Polyp without supporting bundle.
  *b*¹. Canal wall thin, not heavily filled with sclerites.
    *c*¹. Polyps arranged in lobes or "catkins".............. *Litophyton* Forskål.

c^2. Polyps single or only in groups.
d^1. Polyps retractile only into a specialized cup. *Gersamia* Marenzeller.
d^2. Polyps without specialized cup, completely or partly retractile. *Eunephthya* Verrill.
b^2. Canal-wall thick, heavily filled with sclerites.
c^1. Polyps arranged in "catkins" or lobes.......................... *Capnella* Gray.
c^2. Polyps single or only in groups.
d^1. Stem without internal axis.
e^1. Polyps on unbranched fingerlike processes. *Paralemnalia* Kükenthal.
e^2. Stem much branched, polyps on secondary or terminal branches.
f^1. Tentacles with few sclerites, sclerites absent from stomodeal wall of polyps .... *Lemnalioides* Light.
f^2. Tentacles with numerous sclerites, stomodeal walls of polyps with sclerites.. *Lemnalia* Gray.
d^2. Stem with irregular internal axis formed by irregularly arranged sclerites .... *Scleronephthya* Wright and Studer.
a^2. Polyp with supporting bundle.
b^1. Polyps arranged in lobes or "catkins"..................... *Nephthea* Savigny.
b^2. Polyps separate or in small groups.
c^1. Stem without internal axis.
d^1. Polyps arise in bundles or groups.... *Dendronephthya* Kükenthal.
d^2. Polyps arise usually singly................ *Stereonephthya* Kükenthal.
c^2. Stem with an irregular thin axis formed by thick sclerites. *Neospongodes* Kükenthal.

Genus LITOPHYTON Forskål

Litophyton FORSKÅL, Descriptiones animalium, Hauniae (1775) 139. (Type *L. arboreum.*)

Ammothea (Savigny in MS) LAMARCK, Hist. Nat. Anim. sans Vert. 2 (1816) 410 and 411.

Ammothea SAVIGNY, Descr. de l'Egypte, Hist. Nat. Suppl. I, Atlas, Polypes (1817) pl. 2, fig. 6.

Nephthea AUDOUIN, Explic. pl. Savigny (1828) 49 (error).

Neptaea BLAINVILLE, Man. Actin. (1834) 523 (error).

Ammothea EHRENBERG, Abh. Akad. Berlin Jg. 1832 (1834) 283, 284.

Ammothea MILNE-EDWARDS, Hist. nat. Corall. 1 (1857) 123, 124.

Ammothea KLUNZINGER, Korallthiere des Rothen Meeres 1 (1877) 30, 31.

Nephthya DANIELSSEN, Norske, Nordhavs. Exp., Alcyonida 1 (1887) 81, 82.

Ammothea HOLM, Zool. Jahrb. Syst. 8 (1895) 11–16.

Ammothea KÜKENTHAL, Abh. Senckenb. Ges. Frankfurt 23 (1896) 126, 127.

Ammothea MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 129–132.

Lithophytum KÜKENTHAL, Zool. Jahrb. Syst. 19 (1903) 105.

Lithophytum THOMSON and MCQUEEN, Journ. Linn. Soc. 31 (1908).
Lithophytum KÜKENTHAL, Expeditionen S.M. "Pola" 29 (1913) 19.
Lithophytum LIGHT, Philip. Journ. Sci. § D 10 (1915) 1.

The genus *Litophyton* was established by Forskål in 1775 when he described an animal that he called *Litophyton arboreum.* Lamarck was perhaps not acquainted with this work as he gave the name *Ammothea virescens* to a similar animal, which was pictured by Savigny (1817). Audouin, who in 1828 worked out and named the figures of Savigny, started a great confusion in nomenclature when he made the mistake of calling Savigny's *Ammothea* (pl. 2, fig. 6) *Nephthea cordieri,* and calling another animal (pl. 2, fig. 5), a true *Nephthea, Nephthea chabrolii.* This was followed by a greater mistake of Blainville who called pl. 2, fig. 6, *Neptaea innominata* and pl. 2, fig. 5, *Neptaea savignyi.* Ehrenberg, however, brought order to the matter when he established correctly that tab. 2, fig. 6, is *Ammothea.* Later Klunzinger (1877) showed that *Ammothea viriscens* was identical with Forskål's *Litophyton arboreum.* A number of workers, including Holm, Kükenthal, and May, used the name *Ammothea* for some time, but as there is no question that *Litophyton* is the older name, it must be used in preference to *Ammothea.* To some workers, Danielssen (1887), for example, there was no difference between *Ammothea* and *Nephthea.* It was Kükenthal who drew a sharp boundary between these two genera although Kükenthal changed the name *Litophyton* to *Lithophytum.* I am using *Litophyton* as it was the one first used by Forskål.

The following is the diagnosis of the genus *Litophyton:* Colony bushlike or treelike with soft and flexible stem and branches. Polyps nonretractile and without any "Stützbundel," grouped together in the form of lobes or "catkins." Canal walls thin and with only very few scattered sclerites.

Key to the species of Litophyton Forskål.

*a*¹. Polyps present only in lobes at end of branches.
  *b*¹. Polyps in flat umbels at ends of branches.
    *c*¹. Polyp sclerites more than 0.2 mm................ *L. graffei* (Kükenthal).
    *c*². Polyp sclerites less than 0.2 mm................ *L. erinaceum* Kükenthal.
  *b*². Polyps in rounded lobes at upper ends of branches.
    L. carnosum (Kükenthal).
*a*². Polyps in lobes at different levels of branches.
  *b*¹. Sclerites absent from polyp.

c^1. Cortical sclerites only spindles.
d^1. Cortical sclerites finely adorned spindles less than 0.2 mm long. *L. ramosum* (Quoy and Gaimard).
d^2. Cortical sclerites regular spindles more than 0.2 mm long with prominent, rough thorns.
e^1. Stem and branches long and slender.......... *L. lighti* nom. nov.
e^2. Stem and branches short, thick and stout........ *L. rigidum* Light.
c^2. Cortical sclerites spindles and small irregular bodies.
d^1. Branches and lobes short and stout.................... *L. viridis* (May).
d^2. Branches and lobes long and slender........ *L. stuhlmanni* (May).
b^2. Sclerites present in polyps.
c^1. Cortical sclerites without spindles, sclerites are rounded bodies with long thorns .... *L. sanderi* (May).
c^2. Cortical sclerites with spindles.
d^1. Cortical sclerites are spindles and irregular small bodies. *L. arboreum* Forskål.
d^2. Cortical sclerites only spindles.
e^1. Spindles much scalloped and with very large thorns. *L. formosanum* Kükenthal.
e^2. Spindles not scalloped.
f^1. Spindles with few conical warts........ *L. confertum* Kükenthal.
f^2. Spindles with many high thorns.
g^1. Sclerites found in tentacles of polyps only. *L. acutilofolium* Kükenthal.
g^2. Sclerites present in body as well as tentacles of polyps.
h^1. Cortical sclerites more than 0.3 mm long. *L. crosslandi* Kükenthal.
h^2. Cortical sclerites less than 0.3 mm. *L. orientale* sp. nov.

LITOPHYTON LIGHTI nom. nov.

Lithophytum philippinensis LIGHT, Philip. Journ. Sci. 10 (1915) 3, pl. 1.

Colony tall, branches long and flaccid, lobes long and polyps not closely set. Polyp body and tentacles without sclerites.

Colony tall, much branched, bushy or treelike and soft. Main stem gives off a number of long branches at different levels. Lobes are carried on primary and secondary branches which are all slender. Lobes long, elongate, cylindrical, on the average about 20 mm long. Polyps lie singly or in small groups but not crowded. They are 0.6 to 1 mm long and 0.5 to 0.7 mm wide with short thick tentacles. Sclerites absent in polyp body and tentacles. Sclerites of stem cortex are straight or slightly bent spindles 0.2 to 0.45 mm long and 0.025 to 0.04 mm wide with blunt warts and divided tips. Among these are smaller, shorter, and smoother rodlike sclerites with few conical proj-

ections. Cœnenchymal walls with few large spindles, 0.8 mm long and 0.08 mm wide, covered with small projections.

In life the stem is light yellow or brown, while the polypary is brownish green to green. Light's type (C–246) and cotype were obtained in Little Balatero Cove, Puerto Galera Bay, Puerto Galera, Mindoro, and Taytay Bay, Palawan, respectively. This is the commonest species of *Litophyton* in Philippine waters.

Ammothea is a synonym of *Litophyton*. May described a form which he called *A. digitata* var. *philippinensis* that at the time of Light's writing (1915) was *L. digitata* var. *philippinensis*. In the present paper, I am showing that this form is *Lemnalia philippinensis*. Even so, the specific name *L. digitata philippinensis* was preoccupied at the time of Light's writing. I have, therefore, changed the name of this species to *L. lighti*.

LITOPHYTON RIGIDUM Light.

Lithophytum rigidum LIGHT, Philip. Journ. Sci. § D 10 (1915) 5, pl. 2.

Colony low, stout, with short, thick stem and branches, lobes short and polyps rather crowded. Polyp body and tentacles devoid of sclerites.

Colony short, stout with rigid stumpy appearance. The base gives rise to a number of cylindrical, swollen, fleshy stems. These in turn give off, mostly at their ends, two or more short main branches. The lobes are carried on short, almost invisible, lateral and terminal branches arising from these main stems. Lobes thick or conical, about 9 mm long and 3.5 mm wide at base. Polyps 0.5 to 0.8 mm high and 0.4 to 0.7 mm wide, tubular or club-shaped, arranged singly or in groups. Polyp bodies and tentacles without sclerites. Polyp groups have a crowded appearance. Sclerites of cortex are straight or curved spindles 0.15 mm to 0.4 mm long and 0.02 to 0.04 mm wide, with large irregular projections, mostly conical or slightly flattened. Ends of sclerites irregular and usually divided. Among spindles are few rod-shaped sclerites, 0.07 mm long and 0.01 mm wide, with few low warts. Canal walls with few, large, straight, or slightly curved spindles, 0.8 mm long and 0.1 mm wide, with numerous low warts.

In life, colony is greenish to light yellow.

Light's type (C–2097) was obtained from reefs in Taytay Bay, Palawan.

LITOPHYTON ORIENTALE sp. nov. Plate 3, figs. 5a-5d.

Colony tall, much branched, and flabby. Lobes long, and polyps not crowded. Sclerites absent in terminal branches and body of lobes, but present in polyp body and tentacles.

A portion of a large colony, much branched like a tree. Terminal branches tend to come out in groups, or four of them arising from almost the same level as the larger branches. Lobes 10 to 15 mm long and 2 to 3 mm wide, arising only from terminal branches, which are 30 to 45 mm long. Polyps on lobes not crowded nonretractile, 0.7 to 0.9 mm long, and 0.4 to 0.5 mm wide with slender tentacles 0.32 mm long and 0.08 mm wide, provided with six rounded pinnules on either side. Sclerites absent from terminal branches and bodies of lobes but present on polyp bodies and tentacles. Those on polyp body are sticks 0.12 mm to 0.15 mm long and 0.019 to 0.03 mm wide with relatively large warts. Sclerites of tentacles are numerous, tiny, flat, irregular sticks, 0.037 mm long and 0.0074 mm wide, laid down with no special arrangement. Main branches have thin cortex, and the longitudinal lines separating the outer canal walls from the cortex are clearly visible. Cortical sclerites are straight or slightly curved spicules, 0.22 mm to 0.32 mm long and 0.025 to 0.045 mm wide, with rather prominent simple warts or knobs. Ends rugged, but no central axis which supplies the end knobs is visible. A few cortical sclerites are shorter and thinner. Gastric canal walls thin and contain only very few spindles 0.27 to 0.76 mm long and 0.064 to 0.11 mm wide with low rounded or irregular warts all around.

Polyps are buffy brown, while the stem and branches are light vinaceous fawn.

Type: No. C–5011, University of the Philippines zoölogical collection. From Large Balatero Cove, Puerto Galera, Mindoro.

This form approaches *L. lighti* nom. nov. in the mode of branching, cortical and canal-wall spiculation. It differs, however, from it and from *L. rigidum* in having prominent sclerites in the polyp body and tentacles. *Litophyton orientale* differs from *L. confertum* in colony growth and in having cortical and polyp sclerites with more-prominent warts. From *L. formosanum* it differs in the form of the colony and in the arrangement of polyp sclerites. In *L. formosanum* the sclerites are in eight double rows, an arrangement totally absent in the present species. It differs from *L. acutifolium* in having

much smaller sclerites in tentacles and cortex of stem and in having sclerites on the body and base of the polyps. From *L. crosslandi*, it differs in having larger lobes, but smaller sclerites on the polyp body.

Genus CAPNELLA Gray

Capnella GRAY, Ann. & Mag. Nat. Hist. IV 3 (1869) 129.
Paranephthya WRIGHT and STUDER, Challenger Report, Zoöl. 31 (1889) 227.
Paraspongodes (ex parte) KÜKENTHAL, Abh. Senckenb. Ges. Frankfurt 23 (1896) 132.
Paraspongodes (ex parte) MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 145.
Paranephthya STUDER, Alcyon. de l'Hirondelle (1901) 30.
Capnella KÜKENTHAL, Zoöl. Jahrb. Syst. 19 (1903) 127.
Capnella LIGHT, Philip. Journ. Sci. § D 8 (1913) 435.

We owe the establishment of the genus *Capnella* to Gray (1869) when he renamed *Alcyonium imbricatum* Quoy and Gaimard *Capnella imbricata* and gave the first diagnosis of the genus. Gray's work evidently did not come to the notice of Wright and Studer, who in 1889 published the name *Paranephthya* and a diagnosis similar to that given by Gray. When Kükenthal created his genus *Paraspongodes* (1896), he included *Paranephthya* under it, which example was followed by May. In 1901 Studer again revived the genus *Paranephthya*, but as the older name should be followed, Kükenthal in his revision of the Nephthyidæ (1903) settled the matter by using the name *Capnella*. Kükenthal, however, gave a diagnosis which can no longer be held in the light of the work of Light (1913). Kükenthal characterized *Capnella* as always having "Blattkeulen," but as will be seen in this paper a number of the members of the group do not possess such foliaceous club in the polyps. Light's diagnosis is excellent and is reproduced as follows:

The colony is upright, tree-like or bushy; the nonretractile polyps, without "Stützbundel," are grouped on lobes or scattered singly on branches and twigs, and are thickly covered with a coat, usually one spicule deep, of minute foliaceous clubs or clubs and spindles which is continued with some changes in the form of the spicules on to the stem cortex. The canal walls contain numerous spindles, clubs or cross-shaped spicules. The canals are numerous and small with fairly thick walls. Their cavities are sometimes very small or lacking in the center of the stem, resulting in the formation of an irregular central axis.

Thirteen species and varieties have been described as belonging to the genus. A revision of the group, however, shows that there are only seven valid species, as follows:

1. CAPNELLA IMBRICATA (Quoy and Gaimard).
   Capnella capitulifera (Wright and Studer).
   Capnella philippinensis Light.
   Capnella philippinensis var. *mindorensis* Light.
   Capnella philippinensis var. *arborea* Light.
   Capnella philippinensis var. *albida* Light.
2. CAPNELLA SPICATA (May).
3. CAPNELLA RAMOSA Light.
4. CAPNELLA PARVA Light.
5. CAPNELLA FUNGIFORMIS Kükenthal.
6. CAPNELLA RUGOSA (Kükenthal).
   Capnella gilchristi Thomson.
7. CAPNELLA MORULA Thomson and Mackinnon.

The reasons for so placing *C. capitulifera* and *C. philippinensis* are set forth under the description of *C. imbricata.* Thomson created his new species *C. gilchristi* as distinct from *C. rugosa* in the belief that its sclerite arrangement is wholly different, Kükenthal not having described such an arrangement of sclerites in his diagnosis of *C. rugosa.* However, I had occasion to examine Kükenthal's material of *C. rugosa* very carefully and found that a similar sclerite arrangement occurs. This, together with the identical types and measurements of the sclerites in the two, makes me place *C. gilchristi* as identical with *C. rugosa.* In addition to the seven species, I am naming *Capnella sabangensis,* making the number of valid species eight.

Key to the species of the genus Capnella Gray.

*a*¹. Polyp sclerites capstans and foliaceous clubs.
C. imbricata (Quoy and Gaimard).
*a*². Polyp sclerites clubs and spindles.
  *b*¹. Polyp sclerites 0.16 mm long or less........................ *C. spicata* (May).
  *b*². Polyp sclerites more than 0.16 mm but less than 0.36 mm long.
    *c*¹. Colony large, bushy, with long pointed lobes........ *C. ramosa* Light.
    *c*². Colony small, compact with rounded lobes.
      *d*¹. Cortical sclerites of stem double spindles............ *C. parva* Light.
      *d*². Cortical sclerites of stem cylinders.... *C. fungiformis* Kükenthal.
  *b*³. Polyp sclerites more than 0.36 mm long........ *C. rugosa* (Kükenthal).
*a*³. Polyp sclerites spindles and irregular sticks.
  *b*¹. Cortical sclerites of stem spindles with long, slender, pointed, closely-set thorns or projections............................ *C. sabangensis* sp. nov.
  *b*². Cortical sclerites of stem spindles with low, blunt warts.
C. morula Thomson and Mackinnon.

CAPNELLA IMBRICATA (Quoy and Gaimard). Plate 3, figs. 1a to e.

Alcyonium imbricatum QUOY and GAIMARD, Voy. Astrolabe, Zool. 4 (1833) 281, pl. 3, figs. 12–14.

Ammothea imbricata MILNE-EDWARDS, Hist. Nat. Corall. 1 (1857) 124.

Capnella imbricata GRAY, Ann. & Mag. Nat. Hist. IV 3 (1869) 129.

Ammothea imbricata STUDER, Monatsb. Akad. Wiss. Berlin (1878) 634.

Paranephthya capitulifera WRIGHT and STUDER, Challenger Report, Zool. 31 (1889) 227, pl. 36 A, figs. 1*a*, 1*b*; pl. 42, fig. 8.

Paranephthya capitulifera STUDER, Alcyon. aus Sammlung des naturhist. Mus. Lubeck (1894) 127.

Paraspongodes capitulifera MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 154, 155.

Capnella capitulifera KÜKENTHAL, Zool. Jahrb. 19 (1903) 128.

Capnella philippinensis LIGHT, Philip. Journ. Sci. § D 8 (1913) 436.

Colony compact looking, treelike, with very short branches. Sclerites of polyps capstanlike and foliaceous clubs. Those of stem cortex also capstanlike; canal walls with four-rayed sclerites.

Colony treelike, usually branching, with polyps arranged in lobes around the terminal branches. In contracted specimens the polyps may be so compactly arranged as to appear to be overlapping each other. Polyps are from 1.8 to 2.2 mm high and 0.8 to 1.5 mm wide. Tentacles are short, blunt, with about twelve pairs of closely packed pinnules. Armature of polyps consists of capstanlike sclerites, 0.075 to 0.1 mm high and 0.06 to 0.075 mm wide, and foliaceous clubs, 0.12 to 0.17 mm long and 0.04 to 0.07 mm wide. Sclerites of stem cortex are similar to the capstanlike sclerites of the lower portion of the polyps, forming a densely packed layer. Inner cortical sclerites are few, in the form of small, smooth, four-rayed sclerites, 0.16 mm long and 0.14 mm wide. Stalk canal walls full of 4-rayed sclerites, 0.18 to 0.22 mm long and 0.16 to 0.2 mm wide, irregular, thick or barrel-shaped sclerites, 0.17 to 0.28 mm long and 0.16 to 0.24 mm wide with very numerous, rounded, compactly arranged warts. Basic form of canal-wall sclerites is the four-rayed type, which, by growth and wart formation, may transform into irregular, rounded, or barrel-shaped sclerites with prominent and heavy warting. Color in life from very light brown to light green.

Reported from New Ireland and the Philippines.

Kükenthal's description of the species was based on three small specimens, two from the Hamburg Museum obtained from

Duke of York, New Ireland, and one in the Berlin Museum from the Gazelle-Carteret-Hafen collection of unknown origin. Kükenthal's description of *C. capitulifera* was based on one specimen obtained from Sulu Sea, Philippines. Light described *C. philippinensis* from fifty specimens from various parts of the Philippines. My own collection consists of four specimens from Puerto Galera, Mindoro. Both lots were taken to Berlin for comparison. Examination of the material labelled *C. imbricata, C. capitulifera,* and *C. philippinensis* revealed that they are identical in skeletal composition. Light established his new species as a result of Kükenthal's statement that "Blattkeulen" are present in the canal walls of *C. capitulifera*. These, however, are not present in the specimens of *C. capitulifera* of Kükenthal that I have examined. *Capnella philippinensis* was distinguished from *C. imbricata* in the structural difference of the sclerites of the stem cortex and polyps. Such a difference, however, does not exist, as both capstanlike and foliaceous sclerites are present in the polyps of both and capstanlike armature is also present in the cortex of *C. imbricata*. I have examined the armature of about forty Philippine specimens that I had labelled *C. philippinensis,* and I found no way in which they differ from those of *C. imbricata*. The dimensions of the cortical and canal sclerites have such a wide variability that no real value can be attached to a difference in the proportion in size between the two.

Light, from a study of fifty lots of Philippine *Capnella,* named three varieties in addition to the typical *C. philippinensis;* namely, var. *mindorensis,* var. *arborea,* and var. *albida*. Some of my material falls under each of these, but there are also specimens that cannot be placed under any one of them due to the extreme variability in the external form of the species. It is thought wise, therefore, to include all these varieties under *Capnella imbricata*.

CAPNELLA RAMOSA Light. Plate 3, fig. 3a.

Capnella ramosa LIGHT, Philip. Journ. Sci. § D 8 (1913) 448, pl. 2, figs. 1–3; pl. 3, figs. 2*a*–2*g*.

Colony large, bushy, with very long slender branches. Polyp sclerites small, straight or curved spindles and thorny or foliaceous clubs. Cortical sclerites clubs and small thick spindles. Canal walls with thick spindles, double spindles, or barrels.

Colony treelike and bushy with numerous slender branches. Polyps scattered in twos or threes all over primary, secondary, and terminal branches. Polyps about 2 mm high and 1.2 mm wide at the tentacular region. Tentacles thick and plump with closely packed pinnules. Sclerites of polyps are straight or curved spindles, 0.21 to 0.26 mm long and 0.016 to 0.03 mm wide, with numerous, fine but prominent warts and clubs, 0.18 to 0.24 mm long and 0.05 to 0.06 mm wide, with warty or foliaceous head. Sclerites of stem cortex are stout spindles, 0.16 to 0.2 mm long and 0.05 to 0.114 mm wide, with warty or toothed head. Canal walls contain numerous stout spindles, 0.14 to 0.2 mm long and 0.08 to 0.1 mm wide, and double spindles or cylinders, 0.16 to 0.2 mm long and 0.06 to 0.08 mm wide with heavy warts.

Stem and main branches with narrow canals and with thick walls so that large stems may have irregular axislike center.

From Sabang Cove, Mindoro, Philippines.

Colony large; the one described by Light has a total height of 130 mm and a breadth of 100 mm. Color olive-green with a grayish tinge.

CAPNELLA PARVA Light. Plate 3, figs. 4a, 4b.

Capnella parva LIGHT, Philip. Journ. Sci. § D 8 (1913) 446, pl. 1, fig. 8; pl. 2, figs. 3*a*-3*e*.

Colony small, rigid, treelike, with short branches. Polyps sclerites simple spindles and clubs. Cortical sclerites thick, short, double spindles. Sclerites of canal walls barrels and double-spindle clubs.

Colony small, rigid, slender, and treelike. Distal part of stem divides into a number of branches on which the lobes of polyps are arranged. Lobes cylindrical with rounded ends, about 4 mm high and 2.5 mm wide. Sclerites of polyps are clubs with few but prominent warts, 0.14 to 0.3 mm long and 0.03 to 0.08 mm wide with few but prominent warts, especially at the head, and spindles, straight or curved, 0.21 mm to 0.29 mm long and 0.03 mm to 0.08 mm wide also with few small or large warts. In the stem cortex are short, rounded, double spindles, 0.11 mm to 0.115 mm long and 0.05 to 0.08 mm wide, with high, narrow warts, and irregular clublike bodies, 0.08 mm to 0.125 mm long and 0.04 to 0.076 mm wide. Cœnenchymal sclerites in canal walls barrels, double spindles, or irregular forms, 0.15 mm to 0.2 mm

long and 0.09 mm to 0.1 mm wide. In addition, some irregular knobbed clublike forms, 0.095 mm to 0.133 mm long and 0.079 to 0.107 mm wide, are also present.

From Bantayan Islands, off Cebu.

Colonies small, the largest known has a height of 32 mm.

CAPNELLA SABANGENSIS sp. nov. Plate 3, figs. 2a, 2b.

Colony low with very short base, lobes and polyps small, polyp sclerites simple spindles and irregular sticks, cortical sclerites spindles with long pointed warts, canal walls with large spindles with numerous low warts.

Colony shrublike with low wide base, usually wider than high. This gives rise to short, almost invisible branches on which the lobes of polyps are thickly set. Lobes small, the largest about 3 mm high and 2 mm wide. They are compactly arranged, those situated internally partially hidden by those situated externally. Polyps very small, about 0.3 mm to 0.4 mm high with their apical ends slightly bent towards center of lobes so as to hide the mouth openings. Polyps with simple, slender, straight or curved spindles, 0.2 to 0.6 mm long and 0.12 to 0.3 mm wide, with fine warts mostly towards the ends, and irregular sticks, 0.1 to 0.2 mm long and 0.01 to 0.03 mm wide, with numerous prominent projecting thorns. The spindles lie superficially and are arranged longitudinally around the polyps, but not gathered together to form a supporting bundle. The irregular sticks lie most internally and have no definite arrangement. In stem cortex are spindles or clubs, 0.2 to 0.4 mm long and 0.02 to 0.05 mm wide (excluding spines), with numerous, prominent projecting thorns. A few are smaller and with only few warts. In the canal walls are large stout spindles, 0.5 to 1.15 mm long and 0.07 to 0.18 mm wide, with numerous low warts. Few of these may be forked or otherwise branched. Color in life, yellowish green.

Type: No. C–5012, University of the Philippines zoölogical collection, collected from Sabang Cove, Mindoro, Philippines.

This species is described from three examples. The largest is 28 mm high and 35 mm wide; another is 23 mm high and 31 mm wide; the third is 16 mm high and 18 mm wide. This species approximates *C. morula* in having the polyps slightly incurved so as to hide the mouth openings. It differs from it, however, in spiculation. *Capnella sabangensis* has the smallest polyps and lobes of any member of the genus.

Genus PARALEMNALIA Kükenthal

The genus was established by Kükenthal in 1913 when he renamed *Lemnalia thyrsoides* Ehrenberg, *Paralemnalia thyrsoides*. Until 1903 this species had been taken along with the group *Ammothea* which of course is now *Litophyton*. In 1907, however, Reinhart studied the minute anatomy of this species together with other species of Alcyonacea and concluded that it differs from most species of *Litophyton* in having a well-developed canal system deep under the ectoderm. It also differs from the other members of this genus in having the gastric canals of the polyps extending down to the base of the colony and in having a distinct structure of the lateral and ventral gastral filaments. Reinhart himself came to the conclusion that the genus *Litophyton* was bulky and needed splitting. Such a move was followed by Kükenthal (1913) when some of the former species belonging to *Litophyton* were transferred to *Lemnalia* and *Ammothea thyrsoides* to the new genus *Paralemnalia*. Kükenthal had in his possession a number of examples of this form, and it became evident to him that it did not fit into the genus *Lemnalia*. It is to be regretted that Thomson and Dean (1931) were not convinced of the validity of the genus. Their main contention, however, based on the variable retractibility of the polyps, cannot hold. Kükenthal himself observed this phenomenon, which led him to detect the retractibility of the polyps. The fact remains, however, that the habitus of *Paralemnalia* is different from that of *Lemnalia*. The colony is composed of a number of fingerlike, unbranched, main stems arising from a common flat or upright base. The polyps, which in *Lemnalia* are confined on the terminal branches and branchlets, are here all over the undivided main stems. These two characteristics, with the complete retractibility of the polyps as well as that of the different mode of canal formation, to my mind, warrant the recognition of the genus.

PARALEMNALIA THYRSOIDES (Ehrenberg). Plate 2, fig. 1; Plate 4, fig. 9.

Paralemnalia thyrsoides KÜKENTHAL, Zool. Ergeb. 29 (1913) 1–33.

From a very extensive, spreading, thin base, numerous cylindrical fingerlike processes arise. These are single, extending upward without branching, although usually two or three may be fused at their bases where they arise from the base. The lobes may be as large as 55 mm long and 8 mm in diameter, although the majority are around 35 mm long and 6 mm wide. The polyps

are uniformly distributed over the lobes from the base to the tip. They are about 1 mm apart, sessile and retractile; in many cases only the apical portions and the tentacles are visible from the outside.

In the cortex base are small, straight sticks or spindles, 0.6 to 0.11 mm long and 0.15 mm wide, with few but prominent warts, which may be arranged in two or more separate girdles. In the cœnenchyma just under the cortex are numerous, smooth, slender spindles, 0.35 to 0.45 mm long and .02 mm wide, with few, very fine, widely separate warts. In the cortex of lobes and polyps are sticks or clubs similar to those of the base, although slightly larger, 0.13 to 0.15 mm long. A few reach a length of 0.18 mm. In the cœnenchyma of the lobes are sclerites similar to those of the base. In the tentacles are minute sclerites 0.03 to 0.05 mm long with prominent warts also arranged in zones.

Philippine material (C–672) was obtained from Bantayan Islands. Several small colonies were collected from Puerto Galera, Mindoro.

Genus LEMNALIOIDES Light

Lemnalioides LIGHT, Philip. Journ. Sci. § D 9 (1914) 233.

Light (1914) working on a collection of Alcyonacea from the Philippines established this genus from a specimen collected from Puerto Galera Bay, Mindoro. The colony is much branched like that of *Lemnalia,* showing a definite bare, sterile, basal region and polyp-bearing branches. Like *Lemnalia* and unlike *Paralemnalia, Lemnalioides* often has the polyps in small groups on the lateral and terminal branches. The polyps, which are tubular and nonretractile, have no stomodeal sclerites and have only very few sclerites in the tentacles. The polyps, also, unlike those of *Lemnalia* and *Paralemnalia,* have numerous mesenterial filaments, which extend to the base of the colony. Light's diagnosis of the genus is as follows:

The colony is upright, treelike, or bushy, and consists of a number of stems coalesced in one or more groups for some distance above the base. The tubular, nonretractile polyps are scattered singly or in little groups on the branches and lateral and terminal twigs. The spiculation of the cortex and the canal walls is similar to that in *Lemnalia.* The tentacles contain a very few, very small, scattered spicules, and the stomodæum contains no spicules. The tentacles bear more than one row of pinnules, and show a median longitudinal band of muscle fibers on their outer surfaces. The type of the genus is *Lemnalioides kükenthali* sp. nov.

LEMNALIOIDES KÜKENTHALI Light.

Lemnalioides kükenthali LIGHT, Philip. Journ. Sci. § D 9 (1914) 233, pl. 1; text figs. 1–6.

Colony consists of two main stalks, which divide to form a number of stems. These in turn divide and subdivide to form several branches that arise close together. These finally give rise to numerous lateral and terminal twigs. Polyps scattered singly or arranged in small groups. They are more or less tubular and nonretractile, 1 to 2 mm long and 0.05 mm wide. Tentacles are prominent with two rows of short but thick pinnules on either side. Polyp sclerites are sparsely arranged, smooth, irregular, bent or curved spindles, 0.15 to 0.2 mm long and 0.005 to 0.008 mm wide, with finely divided tips. Cortical sclerites of stems and branches are curved spindles, 0.15 to 0.29 mm long and 0.008 to 0.02 mm in diameter, with few widely separate warts. Among the spindles are few, heavier, curve sclerites whose convex sides show few prominent projections. In the cortex towards the base they become shorter and heavier-looking and develop numerous blunt projections on the convex side. In the extreme base the cortical sclerites are double stars and capstanlike, 0.06 to 0.08 mm long and 0.02 to 0.07 mm in diameter.

In the cœnenchyma are smooth sticks with few low warts and finely divided tips. These are 0.25 to 0.5 mm long and 0.009 to 0.026 mm wide.

Light's type (C–2611) has a total height of 115 mm and a polypary expanse of 110 mm with a base 38 mm long and 25 mm wide. "The stem is yellowish brown and the polyp-bearing portion is light brown in formalin."

Locality: Puerto Galera Bay, Mindoro.

Genus LEMNALIA Gray

Lemnalia GRAY, Ann. & Mag. Nat. Hist. 2 (1868) 442.
Lemnalia GRAY, Ann. & Mag. Nat. Hist. IV 3 (1869) 130.
Lemnalia BOURNE, Trans. Linn. Soc. London 7 (1900) 527.
Lemnalia KÜKENTHAL, Zool. Jahrb., Syst. 19 (1903) 133.
Lemnalia KÜKENTHAL, Exp. S. M. "Pola," Alcyon. des Roten Meeres 29 (1913) 14.
Lemnalia LIGHT, Philip. Journ. Sci. § D 9 (1914) 242.

The genus *Lemnalia* was established by Gray in 1868 from a hitherto undescribed alcyonacean which he called *Lemnalia jukesi*. In this work he also correctly included under his new genus *L.*

terminalis, formerly *Alcyonium terminale* (Quoy and Gaimard), and *L. nitida,* formerly *Ammothea nitida* of Verrill. Bourne (1900) emended the diagnosis of the genus and described two new species, *L. rhabdota* and *L. peristyla.* Kükenthal (1903) in his revision of the family Nephthyidæ, added a new species, *L. umbellata,* and another, *L. cervicornis* (formerly *Ammothea cervicornis* of May). In the same revision, he included five species of *Ammothea* under the revived genus of *Litophyton,* which later (1913), however, he transferred correctly to the genus *Lemnalia.* These are *L. africana* (May), *L. flava* (May), *L. elegans* (May), *L. brassica* (May), and *L. armata* (Kükenthal). Light, while working on his genus *Lemnalioides,* identified and named three species of *Lemnalia* from the Philippines, the descriptions of which remain unpublished. These are *L. kükenthali, L. bournei,* and *L. bantayensis.* Light's *L. kükenthali,* however, is identical with May's *Ammothea digitata* var. *philippinensis,* so that I am calling it *Lemnalia philippinensis* (May). In addition to these I am reporting here four species of *Lemnalia* which are apparently new; namely, *L. grandispina, L. faustinoi, L. scasa,* and *L. zimmeri.* A form similar to *L. laevis* Thomson and Dean is also represented in this collection.

The genus *Lemnalia* may be diagnosed as follows: The colony which arises from a common broad basis is composed of several much-branched stems that are oftentimes coalesced with each other for a certain distance of their length. The polyps which arise singly, in small groups or in bundles but never in lobes or catkins, are found either arising from the tertiary or terminal twigs, and are not retractile. Stem cortex smooth-looking but with numerous sclerites, spindles, clubs, double stars, modified double stars with two long projecting thorns on either side, or crescent-shaped. Canal walls very thin, but full of a dense matting of spindlelike sclerites. Polyps usually provided with small spindles with fine warts, while the tentacles have either tiny spindles with fine warts or flat scales with granular surface. Tentacles have only one row of pinnules on either side. Stomodeal wall of polyps with tiny spindles with prominent projecting thorns.

The genus as so diagnosed differs markedly from *Litophyton* in having the polyps not arranged in lobes or catkins but singly or in small groups or bundles. In *Litophyton* the lobes are found on the main stems as well as in different levels of the

branches, while in *Lemnalia* they are found only in the upper portion of the colony quite separate from the sterile trunk. Another marked difference lies in spiculation. The canal walls of *Litophyton* is almost or entirely free from sclerites. If these are present, they are very few and very large. Finally *Litophyton* is very smooth and slimy to feel and the colony is very soft and pliable. The differences between *Lemnalia* and *Paralemnalia* will be set forth in the part dealing with the latter.

Key to the species of the genus Lemnalia Gray.

*a*¹. Polyps numerous, closely set, arranged in spikes.
  *b*¹. Sclerites of tentacles tiny, warty spindles.
    *c*¹. Colony low, massive, terminal twigs broad and stout.
      *d*¹. Cortical stem sclerites with double stars.... *L. bournei* Light MS.
      *d*². Cortical stem sclerites with spindles only........ *L. brassica* (May).
    *c*². Colony slender, terminal twigs elongate.
      *d*¹. Terminal twigs small, short.................... *L. bantayensis* Light MS.
      *d*². Terminal twigs large, long.
        *e*¹. Cortical sclerites without double stars.
          *f*¹. Cortical sclerites without irregular clubs.
            L. umbellata Kükenthal.
          *f*². Cortical sclerites without irregular clubs.
            *g*¹. Cortical sclerites are bent, warty spindles. *L. flava* (May).
            *g*². Cortical sclerites are straight, smooth spindles.
              L. africana (May).
        *e*². Cortical sclerites with double stars.
          *f*¹. Cortical sclerites only double stars............ *L. elegans* (May).
          *f*². Cortical sclerites crescents and double stars.
            L. philippinensis (May).
  *b*². Sclerites of tentacles, flat scales with finely granular surface.
    *c*¹. Colony low, terminal twigs short.
      L. squamifera Thomson and Dean.
    *c*². Colony high, terminal twigs longer.
      *d*¹. Cortical sclerites spindles only............................ *L. jukesi* Bourne.
      *d*². Cortical sclerites warty spindles and irregular double stars.
        *e*¹. Double stars stout and short.........................*L. rhabdota* Bourne.
        *e*². Double spindles narrow, longer..................... *L. peristyla* Bourne.
*a*². Polyps not numerous, not crowded, not arranged in spikes.
  *b*¹. Polyps sessile, not stalked.
    *c*¹. Terminal branches very short and stout........ *L. armata* Kükenthal.
    *c*². Terminal branches long and slender.
      *d*¹. Terminal twigs less than 1 mm in diameter, polyps globular.
        L. scasa sp. nov.
      *d*². Terminal twigs more than 1 mm in diameter, polyps flat.
        L. zimmeri sp. nov.
  *b*². Polyps shortly pedicellate.
    *c*¹. Colony branched only at extreme apical portion.

d^1. Polyps short, cortical stalk sclerites spindles only.
L. faustinoi sp. nov.

d^2. Polyps long, cortical stalks sclerites with modified double-stars.
L. cervicornis (May).

c^2. Branching of colony starts from lower part.

d^1. Colony tall, large, cœnenchymal sclerites branched at ends.
L. laevis Thomson and Dean.

d^2. Colony low, medium sized, cœnenchymal sclerites not branched at ends.

e^1. Cortical sclerites only large double stars.
L. grandispina sp. nov.

e^2. Cortical sclerites with crescents and modified double stars.

f^1. Stem dichotomously branched........................... *L. nitida* Bourne.

f^2. Stem not dichotomously branched.
L. terminalis Bourne.

LEMNALIA BOURNEI Light MS. Plate 4, fig. 1.

Colony low, stem short. Polyps closely set on very short terminal branches. Sclerites of stem cortex irregular double stars and crescents. Sclerites of canal walls, polyps, and tentacles are spindles with few or many warts.

The stem is very short and stumpy, coalesced together for about one-half to one-third of entire length to form a common base. The stems at their extreme ends give off several very short, almost unnoticeable, stout secondary branches from which the terminal twigs arise. Terminal branches also very short, never more than 15 mm long and 2 mm wide. Stem smooth-looking but granular to the touch. Polyps sessile, arranged very close together and regularly all around the terminal twigs, appearing in badly contracted specimens as if they were in lobes. They are nonretractile, but very contractile, protruding only very slightly over the surface of the terminal branches. Polyps and tentacles with numerous sclerites in the form of tiny spindles. Sclerites of polyp body are arranged horizontally while those of the tentacles are diagonally or longitudinally placed. Cortical sclerites of stem are bent or crescent-shaped spindles, 0.15 to 0.2 mm long and 0.02 mm wide, with prominent warts, and irregular double stars, 0.08 mm long and 0.03 mm wide, with one ray of each star produced into a spinous process. There are forms intermediate between the double stars and the crescents. In the canal walls is a dense matting of simple straight spindles, 0.2 to 0.46 mm long and 0.015 to 0.02 mm wide, with few or many fine warts. Those in the polyps are similar sclerites, 0.22 to 0.27 mm long and 0.01 mm wide. Those in the tentacles are still smaller, 0.18 mm long and 0.01 mm wide, also with fine warts.

Colony usually small; Light's type, No. C–238, University of the Philippines zöological collection is about 60 mm in total height. Color in life olive-gray or Quaker drab.

This species is closest to *L. brassica* (May) in external form, in that both of them are low with short stout stems. The terminal branches of *L. brassica,* however, are more prominent, the polyps are very large and the spiculations of the two are entirely different. In skeletal formation, *L. bournei* is nearest to *L. rhabdota* Bourne, although the flat, scalelike sclerites of *L. rhabdota* are entirely wanting in the present species. This is the commonest species of *Lemnalia* in the Puerto Galera region.

LEMNALIA BANTAYENSIS Light MS. Plate 4, fig. 2.

Colony tall, with slender stems and branches. Polyps sessile, much crowded on short terminal twigs. Sclerites of polyps spindles, of cortex crescents or bent spindles and ordinary clubs.

Colony composed of several tall, smooth, slender stems which are coalesced only for a very short distance from the base. Each main stem divides into two equal or unequal long or short but slender secondary branches which in turn give rise to the tertiary branches. Tertiaries may give rise to twigs of the fourth order or direct to terminal branches. Terminal twigs small, short, and slender, at most 12 mm long and 2 mm wide. Polyps sessile and crowded together on the terminal twigs. Sclerites of polyps and tentacles are very thin, slender spindles. Those in the polyp bodies are about 0.2 mm long; those in the tentacles are 0.05 to 0.08 mm long. Sclerites of stem cortex are crescent-shaped or bent spindles or clubs, 0.13 to 0.18 mm long and 0.02 mm wide, with few but prominent warts. Double stars or irregular sclerites are absent. In the canal walls are very numerous, simple, straight spindles, 0.2 to 0.4 mm long and 0.01 to 0.025 mm wide, with fine warts.

Colony of medium size, Light's type, No. C–248, University of the Philippines zoölogical collection, is 50 mm in total height. The type from Bantayan Island, off Cebu.

Unlike *L. philippinensis* the most numerous cortical stalk sclerites of this species are crescent-shaped forms, while the true double stars or irregular sclerites are absent. Also the polyps are crowded, unlike those in *L. philippinensis* where they are evenly and singly placed on the tertiary twigs. It has smaller sclerites than *L. flava* (May) and it differs from *L. umbellata* Kükenthal in the absence of very irregular clubs in the cortex.

LEMNALIA PHILIPPINENSIS (May). Plate 4, fig. 3.

Ammothea digitata var. *philippinensis* MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 137.

Lemnalia kükenthali LIGHT MS.

Colony tall but not very slender. Polyps arranged singly or in small groups on large, prominent, terminal branchlets. Sclerites of stem cortex are crescents and double stars. Sclerites of polyps spindles.

Colony composed of several, large, tall stems that are coalesced for about one-fourth to one-half of their entire length. Each main stem gives rise to several secondary branches, which after some distance enlarge and divide into tertiaries. Tertiaries give rise to many terminal twigs 10 to 20 mm long and 2 mm wide. Polyps located on tertiary as well as on terminal twigs. They are subsessile and crowded, but may appear singly on the tertiary twigs. On the exposed part of polyps are narrow spindles 0.15 to 0.25 mm long, while those of the tentacles are also tiny spindles 0.03 to 0.05 mm long with fine warts arranged more or less transversely on the tentacles. Sclerites of stem cortex are crescent-shaped or bent spindles, 0.15 to 0.3 mm long and about 0.02 mm wide, with very fine warts and double stars, 0.05 long and 0.02 mm wide at the middle, a few of which may have long spinous rays on each star. Sclerites of the canal walls are thin spindles up to 0.55 mm long and 0.02 mm wide with fine warts.

Colony large, Light's cotype, C–244, University of the Philippines zoölogical collection, has a total height of 105 mm.

This form is nearest to *L. elegans* (May). Its cortical sclerites, however, are longer and slenderer. It differs markedly from *L. bantayensis* in having stouter and shorter secondary but longer terminal branches. May (1899) describes a badly contracted form of this species from Zamboanga as *Ammothea digitata* var. *philippinensis*. The typical species of this, however, was found to be identical with *Alcyonium flabellum* Quoy and Gaimard and was called *Lithophytum flabellum* by Kükenthal in 1903. When Kükenthal established the genus *Paralemnalia* (1913) May's typical species was named *Paralemnalia flabellum*, but *Ammothea digitata* var. *philippinensis* answers all the characteristics of the genus *Lemnalia* instead of *Paralemnalia*. Light named a similar form from Puerto Galera *L. kükenthali*, but as the older name must be used I am calling this *L. philippinensis* (May).

LEMNALIA SCASA sp. nov. Plate 4, fig. 4.

Colony slender, polyps not numerous, sessile, scattered, and rounded. Terminal branches long and very slender. Stalk cortical sclerites are modified double stars; canal wall with pointed and warty spindles. Tentacles with small spindles.

Colony composed of many slender cylindrical stems. Main stems divide below half of entire height of colony into two almost as large secondaries. Tertiaries, however, arise from different levels of the secondaries. Tertiaries give rise to twigs of the fourth order from which the very slender terminal twigs less than 1 mm in diameter are given off. Polyps sessile, globular, and scattered singly on the twigs of the fourth and fifth order, but may be more crowded towards the tips of the terminal branches. Polyps 0.5 to 0.6 mm wide and 0.4 to 0.5 mm high. In the tentacles are fine scalelike sclerites with granular surface, while in the terminal branches and bodies of polyps are fine slender spindles 0.075 to 0.12 mm long, with few warts. Stem cortex provided with modified double stars, crescents, or irregular sticks, 0.15 to 0.2 mm long and 0.01 to 0.025 mm wide with large warts. In the stalk cœnenchyma are numerous slender spindles, 0.2 to 0.43 mm long and 0.02 to 0.04 mm wide, with numerous fine warts.

Colony medium in size with a stalk diameter of 10 mm and a total height of 120 mm. Color in alcohol is light whitish yellow.

Type: No. C–5004, University of the Philippines zoölogical collection, was obtained from Puerto Galera, Mindoro.

This species is closest to *L. zimmeri* in habitus, but the mode of branching, the very slender terminal branches, and the globular polyps separate it distinctly from this species. Also the spiculation is different in the two species.

LEMNALIA ZIMMERI sp. nov. Plate 4, fig. 5.

Colony of medium size, polyps sessile, flat, and scattered on long slender terminal branchlets; tentacles with tiny sticks, cortex with clubs, spindles, and modified double stars.

From a common base several stems of different sizes arise. Each stem just below the middle of the entire height of the colony gives rise to several secondary branches at the same or at different levels. The secondary branches extend for a short distance and then divide to form the tertiaries from which the terminal twigs arise. These are usually long and slender, reaching a length of 20 mm. Polyps are sessile, flat, and scattered on tertiary and terminal twigs. They are about 0.25 mm high

and 0.55 in diameter. Terminal branches and polyp bodies are provided with simple, warty spindles with finely divided tips. Tentacles with tiny sticks with rounded tips. Stalk cortex with spiny clubs 0.2 to 0.25 mm long and 0.03 mm wide, straight or curved spindles 0.2 to 0.35 mm long and 0.04 mm wide, and a few small modified double stars, 0.01 to 0.15 mm long and 0.03 wide. Stalk cœnenchyma is provided with simple spindles, 0.3 to 0.6 mm long and 0.02 to 0.05 mm wide, with few fine warts and finely divided ends.

Type: No. C–5005, University of the Philippines zoölogical collection, has a total height of 80 mm. Color yellowish white. Collected from Puerto Galera Bay, Mindoro.

This species is named after Prof. C. Zimmer, director of the Zoölogical Museum, Berlin.

LEMNALIA FAUSTINOI sp. nov. Plate 4, fig. 6.

Colony small, with small slender stems, much branched at extreme ends. Sclerites of stem cortex are spindles. Polyps pedicelled with spindles.

Colony is composed of several small slender stems joined together only at the extreme basal portion. Each stem extends to over one-half of the entire height of the colony before giving rise to two or more secondary branches. These at once divide into tertiaries from which the terminal twigs are given off. Polyps shortly pedicelled, found either singly or in small groups on the tertiaries and terminal twigs. Free portion of polyps 0.5 to 0.6 mm in diameter and 0.5 to 0.7 mm high. Sclerites of polyps and tentacles are tiny regular spindles, 0.06 to 0.12 mm long and 0.005 mm wide, with few but prominent warts. In the terminal branches are similar but larger spindles 0.2 to 0.35 mm long with proportionally less-prominent warts. Sclerites of stalk cortex are pointed or blunt spindles, 0.13 to 0.27 mm long and 0.02 to 0.03 mm wide, with prominent warts. In the canal walls are similar but more slender spindles, 0.3 to 0.35 mm long and 0.012 to 0.018 mm wide, with less-prominent warts.

Colony small, with stems about 8 to 10 mm in diameter. Total height of type (C–5006) 50 mm. Color in alcohol pure white.

This species is closest to *L. cervicornis* (May). May's description of his species, however, is insufficient. When I examined his cotype, which is in the Berlin Museum, I found modified double stars and clubs in the cortex in addition to the spindles. In the present species no such modified double stars

or clubs are present. Also in *L. cervicornis* the exposed portion of the polyps are much longer, over twice as long as in the present form.

Locality: Puerto Galera Bay, Mindoro.

LEMNALIA LAEVIS Thomson and Dean. Plate 4, fig. 7.

Lemnalia laevis THOMSON and DEAN, Siboga Exp. 13d (1931) 77, pl. 14, figs. 7 and 8.

Colony tall, polyps stalked, separate, in terminal branches; tentacles with scalelike sclerites, cortex with crescents and stalk cœnenchyma with smooth, straight sticks with finely divided tips.

Colony tall, composed of wide base from which the coalesced tall, slightly flattened main stems arise. These extend for some distance before giving rise to secondary branches of different lengths and sizes. The tertiary branches arise closely together but at slightly different levels of the secondaries. Terminals slender but not very long. Polyps pedicelled, separate and coming out at different levels of the terminals only. Polyps 0.5 to 0.85 mm wide and 0.8 to 1.2 mm high. Terminal branches and polyp bodies with simple spindles or sticks with few prominent warts and finely divided tips, but the tentacles are provided with numerous, flat, scalelike sclerites with granular surface. Stalk cortex with modified double stars and crescent-shaped sclerites, 0.05 to 0.125 mm long and 0.02 mm wide, with prominent warts. Stalk cœnenchyma with long straight spindles or stick, 0.2 to 0.45 mm long and 0.01 to 0.02 mm wide, with finely divided tips.

Philippine material (C–5008) has a total height of 110 mm. In alcohol the colony is light yellowish brown, with very smooth stalks.

This species comes closest to *Lemnalioides philippinensis* Light in spiculation, in having the cœnenchymal sticks finely divided at the tips. The presence of numerous sclerites in the tentacles and in the stomodeal wall, places it in the genus *Lemnalia*. Also it has only one row of pinnules in the tentacles.

Previously recorded from Kaniungan Ketjil. Reef; Sulu; and Paternoster Island.

LEMNALIA GRANDISPINA sp. nov. Plate 4, fig. 8.

Colony much branched, treelike. Polyps pedicelled, with bodies and tentacles with fine spindles. Cortex of stalk with double stars; canal walls with sparsely warted spindles.

Colony composed of several stems, which are coalesced only for a short distance near the base. Each stem, at about one-half the entire height of the colony, gives rise to two or three secondary branches. These extend for some distance before giving rise to tertiary branches that come out almost from the same level. Terminal branches arise at different levels of the tertiaries, which thus appear long. Polyps are not numerous, scattered singly or in very small groups on the tertiaries and terminal branches. Polyps 0.6 to 0.75 mm wide and 0.7 to 0.9 mm high, with short pedicels but with more or less rounded ends. Sclerites of polyps as well as those of tentacles are small, almost smooth spindles. In the canal walls are spindles, 0.2 to 0.45 mm long and about 0.02 mm wide, with very few fine warts. In the stalk cortex are large double stars, 0.08 to 0.13 mm long and 0.03 mm wide at the middle, which are heavily warted at the two ends. A few modified double stars, double spindlelike, 0.16 to 0.18 mm long and 0.02 mm wide, are also seen.

Colony of medium size. The type (C–5007), from Puerto Galera, has a total height of 65 mm and main stems about 10 to 15 mm in diameter. Color in life Dresden brown.

This species approaches *L. nitida* in external appearance, but the spiculation is entirely different. In *L. nitida* the sclerites of the tentacles are flat scales with fine granular surface. Here these are tiny spindles. Also in *L. nitida* the cortical stalk sclerites are modified double stars or crescents with two long pointed rays. Here the cortical sclerites are true unmodified double stars. The species is named *L. grandispina* due to the large size of these cortical sclerites.

LEMNALIA NITIDA (Verrill).

Ammothea nitida VERRILL, Bull. Mus. Comp. Zool. Harvard 1 (1869) 39.

Colony greatly branched from base; main stems short and branched dichotomously; polyps pedicelled, separate; tentacles with scalelike sclerites with granular surface; cortex with bent spindles, irregular clubs, and modified double stars.

Colony composed of a very short base from which short stems arise. These at once divide into two more or less equal, short, thick secondary branches. Secondaries then divide into tertiaries from which the terminals are given off. Tertiaries and

terminal twigs bent or curved inwards towards center of the colony. These are numerous and crowded, giving the colony a shrubby appearance. Polyps short stalked, not in groups, but rather closely set. They are situated in tertiaries and terminals. Polyp bodies and terminal branches with fine spindles, but tentacles are provided with flat scalelike sclerites with finely granular surface. Sclerites of cortex are straight or bent spindles, 0.18 to 0.3 mm long and 0.015 to 0.02 mm wide, with prominent warts, irregular clubs 0.08 to 0.1 mm long and 0.02 mm wide at head, with prominent warts, double stars 0.05 and 0.01 to 0.02 mm wide, and modified double stars of similar size but with projecting spines, one on each side. Sclerites of canal walls are straight or slightly bent spindles, 0.25 to 0.45 mm long and 0.015 to 0.02 mm wide, with few warts.

A Philippine example (C–5009) from Puerto Galera is of medium size; total height of colony 40 mm. Color in alcohol whitish yellow with a slight greenish tinge.

Previously recorded from Zanzibar.

Genus SCLERONEPHTHYA Wright and Studer

Scleronephthya WRIGHT and STUDER, Challenger Report Zool. **31** (1889) 229.

This genus was established by Wright and Studer in 1888 on a single specimen from Philippine waters, which they called *Scleronephthya postulosa.* In 1896 the genus was provisionally united by Kükenthal with the genus *Paraspongodes,* which example was followed by May. In 1901, however, Studer gave additional reasons why *Scleronephthya* should be considered a distinct genus, and in 1901 Kükenthal, convinced of Studer's stand, accepted the genus. The following diagnosis may serve to define the genus:

Scleronephthya is a genus of Nephthyidæ in which the animals are treelike, with polyps, not provided with stützbündle, and are arranged in groups, but not in lobes. Polyp sclerites are mostly spindlelike, arranged in oblique rows basally, but horizontally around the polyp just below the tentacles to form a sort of collar. Stem with numerous narrow canals peripherally but with an irregular axislike center composed of numerous spicules packed together.

SCLERONEPHTHYA POSTULOSA Wright and Studer.

S. postulosa WRIGHT and STUDER, Challenger Report, Zoöl. 31 (1889) 229, 230, pl. 36A, figs. 2a, 2c.

Colony treelike and seemingly rigid, composed of a short stem that gives rise to large branches on two series in acute angle. These main branches in turn give off side branches in a very irregular manner. Polyps are either solitary or in groups, on the terminal twigs, main stem, or on main branches. Polyp groups much crowded on end of twigs, but widely separate on stem and larger branches. Polyp heads are club-shaped, about 1 mm long, and just as wide, at right angle with polyp stalk. They are provided with long, bent spindles, up to 0.54 mm long and 0.08 mm thick, with blunt warts. These are arranged in oblique rows in such a way that one spicule may extend half around the polyp head. In addition smaller spindles, about 0.18 mm long and 0.03 mm thick, fill the spaces between the larger spindles. Just beneath the tentacles are spindles 0.25 mm long and 0.025 mm wide, arranged more or less transversely around the polyp, forming a sort of collar. The tentacles are bent inwards, forming together an operculumlike cover over the mouth opening. On the cortex of stem and branches are spindles about 1.14 mm long and 0.1 mm wide. The canals are numerous, irregularly formed, and narrow. They are absent from the inner portion of the stem, so that here is an irregular axis composed of closely packed spindles with rounded warts and oftentimes with swollen ends.

Color in alcohol brownish gray.

Collected by the "Challenger" from a bottom with blue mud under water about 18 fathoms deep in the Visayan Sea. The above description is based on the description of Wright and Studer, as there was no material in our collection.

Genus NEPHTHEA Savigny

Nephthee SAVIGNY, Descr. de l'Egypte, Hist. nat. Suppl. 1 (1817) Atlas Polypes, pl. 2, figs. 51–57.

Nephthea AUDOUIN, Expl. pl. Savigny (1828) 49.

Neptaea BLAINVILLE, Man. d' Actinologie (1834) 523.

Nephthya EHRENBERG, Abh. Akad. Wiss. Berlin, Jg. 1832 (1834) 284.

Nephthya DANA, Zoophytes (1846) 610.

Nephthya MILNE-EDWARDS, Hist. nat. Corall. 1 (1857) 127.

Nephthya KLUNZINGER, Korallth. des Rothen Meeres 1 (1877) 33.

Nephthya STUDER, Arch. Naturg. Jg. 53 1 (1887) 19.
Nephthya (pars) DANIELSSEN, Norske Nordhavs Exp. 5 (1887) 82.
Nephthya plus *Spongodes* (pars) WRIGHT and STUDER, Challenger Report 31 (1889) 25.
Spongodes (pars) HOLM, Zool. Jahrb. Syst. 8 (1895) 24.
Spongodes (pars) KÜKENTHAL, Zool. Anz. Jg. 18 (1895) 248.
Nephthya KÜKENTHAL, Abh. Senckenb. Ges. Frankfurt 23 (1896) 89.
Nephthya MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 156.
Nephthya KÜKENTHAL, Zool. Jahrb. 19 (1903) 147.

After a long mix-up in nomenclature which involves *Nephthea,* it is now certain that the type of this genus is *Nephthea chabrolii* Savigny. As a result of the findings of Ehrenberg (1834), Holm (1895), Wright and Studer (1889), and Kükenthal (1896), the genus has retained a stable position and can now be diagnosed as follows:

Species of *Nephthea* are members of the family Nephthyidæ Verrill with thin canal walls and polyps with supporting bundle, arranged in catkins or lobes.

Diagnosed as such, the genus *Nephthea* is similar to *Litophyton, Gersamia, Eunephthya, Dendronephthya, Stereonephthya,* and *Neospongodes* in having very thin canal walls. However, only the last three genera have sclerites in the polyps arranged in the form of supporting bundles. *Dendronephthya, Stereonephthya,* and *Neospongodes* differ markedly from *Nephthea* as their polyps are never arranged to form lobes or catkins. The only other genera with lobes are *Litophyton* and *Capnella.* However, neither of these has supporting bundles in the polyps; *Litophyton* has very few, if any, large sclerites in the canal walls, while *Capnella* has very numerous, heavily warted sclerites in the cœnenchymal wall.

I am using the name *Nephthea* as this is the first used by Audouin and I do not find anything wrong with it. There are no less than forty-five recognized species of this genus. Only twenty-one have been found to exist in the Philippine waters.

Key to the Philippine species of Nephthea Savigny.

*a*¹. Supporting bundle does not project at all or not prominently beyond polyp head.
  *b*¹. Polyps crowded or uniformly arranged on lobes.
    *c*¹. Lobes definitely longer than broad.
      *d*¹. Polyp sclerites not definitely larger outside than inside.
        N. columnaris Studer.
      *d*². Polyp sclerites definitely larger outside than inside.
        *e*¹. Basal cortical sclerites only irregular radiate forms.
          N. erecta Kükenthal.

e^2. Basal cortical sclerites with spindles.
f^1. Basal cortical spindles not more than 0.07 mm long.
N. bedfordi Shann.
f^2. Basal cortical spindles more than 0.07 mm long.
g^1. Polyp inner sclerites are small warty spindles.
N. chabrolii Audouin.
g^2. Numerous tiny smooth sclerites on inner side of polyp head and polyp stalk .... *N. albida* (Holm).
c^2. Lobes not definitely longer than broad; semispherical or conical.
d^1. Basal cortical sclerites only irregular radiate forms.
N. australis Kükenthal.
d^2. Basal cortical sclerites with spindles and irregular radiate forms.
e^1. Polyp sclerites not arranged in definite double rows.
N. striata Kükenthal.
e^2. Polyp sclerites arranged in definite double rows.
f^1. Stem stout, tall, unbranched below.... *N. laevis* Kükenthal.
f^2. Stem short, branched from below........ *N. brassica* Kükenthal.
b^2. Polyps arranged in groups, not uniformly distributed on lobes.
c^1. Sclerites of basal cortex only spindles........ *N. nigrescens* nom. nov.
c^2. Sclerites of basal cortex spindles and irregular radiate forms.
d^1. Lobes low, more or less rounded, not definitely higher than wide.
N. quercus Kükenthal.
d^2. Lobes elongate, nearly twice as long as broad.
e^1. Inner polyp sclerites at most 0.03 mm long.
N. cupressiformis Kükenthal.
e^2. Inner polyp sclerites about 0.13 mm long.
N. amentacea Studer.
a^2. Supporting bundle projects prominently beyond polyp head.
b^1. Polyps uniformly distributed on lobes, crowded.
c^1. Lobes low or rounded.. *N. globulosa* (May).
d^1. Lobes elongate or conical.
e^1. Basal cortical sclerites only spindles with high warts on one side .... *N. elongata* (Kükenthal).
e^2. Basal cortical sclerites spindles and irregular thorny bodies.
N. pacifica Kükenthal.
b^2. Polyps in groups on lobes, not crowded.
c^1. Basal cortical sclerites spindles and irregular thorny bodies.
d^1. Inner polyp sclerites only slightly smaller than those outside.
e^1. Spindles predominate in basal cortex.
N. debilis (Kükenthal).
e^2. Irregular radiate sclerites predominate in basal cortex.
N. ceylonensis Thomson and Henderson.
d^2. Inner polyp sclerites very tiny flat sticks about 0.07 mm long.
N. zanzibarensis Thomson and Henderson.
c^2. Basal cortical sclerites only spindles.
d^1. Inner polyp sclerites very numerous tiny sticks or rods about 0.07 mm long .... *N. digitata* (Wright and Studer).
d^2. No such numerous tiny sticks or rods present.
N. armata Thomson and Henderson.

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NEPHTHEA COLUMNARIS Studer.

Nephthya columnaris STUDER, Mittl. geogr. Ges. u. naturh. Museum Lubeck (2) Heft 7 u. 8 (1894) 125, pl. 4, fig. 2; pl. 6, fig. 4.

Polyps uniformly distributed on lobes, which are cylindrical or fingerlike; polyp sclerites, outside not decidedly larger than inside; supporting bundle does not extend beyond polyp; polyp heads not longer than broad; polyp stalk not longer than polyp head; only spindles on basal cortex.

Colonies on hand one small and one large. The larger specimen has a total height of 85 mm and the polypary has an expanse of 95 mm. Base very short, giving rise directly to several very short stems, which at once divide into two to six main branches. These in turn divide into secondaries and tertiaries, where the lobes are located. Lobes 5 to 6 mm high and 3 to 4 mm wide. Polyp heads uniformly distributed on lobes, 0.56 mm wide and 0.49 mm long; polyp stalk about 0.3 mm long. Sclerites of polyps with high prominent warts are spindles about 0.17 to 0.21 mm long. A few on the dorsal part are slightly larger. Sclerites of supporting bundle are warty spindles as much as 0.7 mm long. They are more heavily warted towards the tips. On upper cortex are slender spindles 0.49 to 0.56 mm long with fine warts. Sclerites on outer lower cortex are spindles, on the average 0.7 mm long and 0.14 mm wide, with fine warts. Those on the inner cortex are smaller, very warty spindles, 0.21 to 0.49 mm long and 0.7 mm wide, which are especially provided with high thorns on one side. In canal walls are few finely warted spindles as long as 1.3 mm and as wide as 0.21 mm, others are forked, triradiate or four-rayed.

Previously recorded from Dongala, Celebes. Philippine material was obtained from Puerto Galera Bay, Mindoro.

NEPHTHEA ERECTA Kükenthal.

Nephthea erecta KÜKENTHAL, Zool. Jahrb. **19** (1903) 154, pl. 7, fig. 8; pl. 9, figs. 45–47.

Polyps uniformly arranged on rounded lobes; sclerites of polyp head larger outside than inside; polyp head not longer than broad; polyp stalk not longer than polyp head; sclerites of supporting bundle do not protrude definitely out of the polyp head; basal cortex only with irregular, thorny or star-shaped sclerites.

Colony low, massive, and bushy with a total height of 70 mm and a polypary expanse of 80 mm. Base broad, from which

arise several short stems. These at once divide to form numerous branches on which the numerous lobes are attached. Most lobes are low and round, although a few may be elongate, 7 mm high, and 3 mm wide. Polyp heads about 0.7 mm wide and 0.6 mm to 0.7 mm long with a stalk 0.48 mm high. Sclerites on outer side of polyp head are straight or curved spindles, 0.28 mm long and 0.043 mm wide, with prominent warts. They may be irregularly arranged or in double rows, three or four in a row. Those on the inside are smaller sticks 0.06 to 0.08 mm long and 0.014 mm wide. Sclerites of supporting bundle are spindles with warts, the longest of which are 1.3 mm long and 0.11 mm wide, which may or may not extend beyond polyp head. On the cortex of lobes are long slender spindles, as much as 1.7 mm long and 0.084 mm wide, with fine warts. On the upper stem cortex are spindles on the average 0.35 mm long with prominent warts, while on the base are only small star-shaped or irregular bodies with a diameter of 0.12 mm on the average. In canal walls are stout blunt or pointed spindles, on the average 0.98 mm long and 0.21 mm wide, with fine warts.

Recorded from Tonga Island. Philippine material (C–2204) was obtained from the shallow reef on the channel between Palawan and Mataguit Islands connecting Taytay Bay and Shark's Fin Bay, Palawan.

NEPHTHEA BEDFORDI Shann.

Nephthya bedfordi SHANN, Proc. Zool. Soc. London (1912) 514, pl. 62, fig. 8; pl. 53, figs. 11, 12.

Polyps uniformly distributed on elongate lobes that are rounded at tip; polyp sclerites slightly larger outside than inside; sclerites of supporting bundle protrude very little if any beyond polyp head; polyp head longer than broad; polyp stalk longer than polyp head; inner polyp sclerites about 0.11 mm long; basal cortex with spindles and irregular radiate sclerites.

Colony low and broad, bushy in appearance. Numerous branches arise from very low stem which are covered with numerous lobes. Lobes elongate, at most 8 mm long and 3 mm wide with rounded tips. Polyps uniformly distributed around the lobes, although at places the polyp heads are not very closely crowded. Polyp head about 0.63 mm long and 0.56 mm wide, making an acute angle with a polyp stalk about 0.7 mm long. Polyp sclerites on the outside are straight or curved spindles, about 0.25 to 0.28 mm long and 0.03 to 0.04 mm

wide, with few warts. In the inner side are smaller sclerites, usually about 0.098 mm long, in the form of smooth sticks. Supporting bundle poorly developed, its sclerites not protruding beyond polyp head. The sclerites are at most 0.76 mm long. In basal cortex are spindles, at most 0.56 mm long and 0.07 mm wide, with medium-sized warts; shorter but stouter spindles 0.49 mm long 0.14 mm wide with high warts on one side, and irregular sclerites, radiate in general form, with broad rays. The latter measure about 0.12 mm by 0.17 mm. In the cœnenchyma of base are spindles 1.2 mm long and 0.17 mm wide with few low warts. A few are smaller and slenderer, 0.7 mm long and 0.07 mm wide. In addition a few triradiate smooth sclerites may be seen.

Colony in alcohol, dark dirty purplish brown.

Previously recorded from Blakang Mati, Singapore. Philippine material (C–2304) was obtained from shallow water on reefs at Pabellones Island, Palawan.

NEPHTHEA CHABROLII Audouin.

Nephthea chabrolii AUDOUIN, Expl. pl. Savigny (1828) 49.

Polyps uniformly distributed on conical, somewhat elongate lobes; sclerites of polyps decidedly smaller inside than outside; sclerites of supporting bundle do not extend beyond polyp head; polyp heads not longer than broad; in basal cortex are spindles in addition to other forms of sclerites.

Colony consists of a stout, short main stem from which short stout branches arise. These branches may either subdivide or give directly to lobes. Lobes conical, 5 to 7 mm long and 3 to 5 mm wide. Polyps closely set, 0.5 to 0.7 mm high and 0.5 to 0.7 mm wide, standing at a right angle with short stalk about 0.3 mm long. Sclerites of polyps on the outside and lateral side heavily warted spindles, about 0.2 to 0.4 mm long and 0.042 mm wide, arranged in indistinct double rows, six to eight sclerites in a row. Those situated on inside are smaller, slightly warty spindles 0.08 mm long and 0.015 mm wide. Sclerites of supporting bundle long spindles, usually about 0.8 to 0.9 mm long and 0.06 mm wide, with more warts towards one end. On upper portion of stem and on lobes are long slender finely warted spindles as long as 1.2 mm and 0.12 mm thick. On basal cortex are heavily warted stout spindles as large as 1.9 mm long and 0.26 mm thick, clubs, double stars, irregular

thorny sclerites, and other forms variously modified. In canal walls are stout, warty spindles as large as 1.3 mm long and 0.2 mm wide.

Reported from Red, Java, and China Seas, Celebes, Ternate, and New Guinea. Common on reefs at Puerto Galera Bay and Batas Island on the east coast of Palawan.

NEPHTHEA ALBIDA (Holm).

Spongodes albida HOLM, Zool. Jahrb. Syst. 8 (1895) 30–32, pl. 2, figs. 8–10.

Lobes elongate rounded at tip; polyps uniformly distributed; sclerites of polyps outside larger than inside; supporting bundle does not project beyond polyp head; polyp head not longer than wide and polyp stalk shorter than polyp head; basal cortex with spindles and irregular thorny bodies.

Colony medium in size with a total height of 50 mm and a polypary expanse of 40 mm. From a narrow base two short stems arise which branch off into primary and secondary twigs on which the lobes are located. Lobes elongate, rounded at tip, on the average 8 mm high and 3 mm wide. Polyps uniformly distributed on lobes but not crowded. Polyp head about 0.5 to 0.6 mm long and 0.7 to 0.8 mm wide at a right angle with a short polyp stalk about 0.42 mm high. Sclerites of polyp head on the outside and lateral side are spindles, 0.35 mm long and 0.03 mm wide, with scattered but prominent warts arranged in double rows about six in a row. On the inside of polyp head and stalk are numerous smooth narrow sticks about 0.05 mm long and 0.014 mm wide that are also found in the inner side of the polyp stalk. Sclerites of supporting bundle are spindles on the average 0.98 mm long, pointed, and with few warts at ends. In the basal cortex are (*a*) simple spindles, on the average 0.7 mm long and 0.11 mm wide with low warts; (*b*) smaller spindles, on the average 0.4 mm long and 0.07 mm wide, with high thorns on one side; (*c*) irregular thorny bodies on the average 0.14 mm wide and 0.17 mm high, and (*d*) other smaller bodies of various shapes and dimensions. In the canal walls are stout spindles as much as 1 mm long and 0.2 mm wide with few low warts.

Reported from Suez and Red Sea. A Philippine example (C–2015) was obtained from a cable in Legaspi Bay, just opposite the foot of Mount Mayon, 90 m deep.

NEPHTHEA AUSTRALIS Kükenthal.

Nephthea australis KÜKENTHAL, Fauna Sudwest Australiens, Alcyonaria 3 Lief. 1 (1910) 50, pl. 3, fig. 21.

Polyps arranged uniformly around low rounded lobes; sclerites of polyps outside not greater than inside; sclerites of supporting bundle do not project beyond polyp head; polyp head not longer than wide and polyp stalk much shorter than polyp head; only irregular radiate sclerites on basal cortex.

Colony very small, with a total height of 40 mm and a stalk 25 mm high and 7 mm wide. The stalk rises upwards and gives at its end a number of very short, almost invisible branches on which the lobes are located. Upper portion of stem and base of the branches are provided with fine parallel lines or grooves. Lobes very low and rounded, 3.5 mm high and 5 mm wide. Polyps closely crowded uniformly over the terminal lobes. Polyp head about 0.6 mm long and 0.4 mm wide at an acute angle with a very short hardly visible polyp stalk. Sclerites in double rows, about seven in a row, about 0.2 mm long with long warts. Some sclerites are found transversely near base of polyp heads. The few longitudinal sclerites lying between the double rows mentioned by Kükenthal in his type, cannot always be seen in this example. Supporting bundle composed of about eight sclerites, at most 1.1 mm long and do not extend beyond the polyp head. At base cortex are small irregular radiate sclerites with rounded or pointed projections. They measure 0.08 to 0.12 mm in diameter. In the cœnenchyma are weakly warted spindles as long as 1.2 mm.

Unlike Kükenthal's type, which has a reddish tinge, the Philippine example is light yellowish green.

Previously recorded from Shark's Bay, southwestern Australia. My description is based on No. C–50 with no exact Philippine locality.

NEPHTHEA STRIATA Kükenthal.

N. striata KÜKENTHAL, Zool. Jahrb. 19 (1903) 166, pl. 7, fig. 12; pl. 9, fig. 60.

Supporting bundle does not project prominently over polyp head; polyps crowded and uniformly arranged on lobes; lobes not definitely longer than broad, hemispherical or conical, basal cortical sclerites, spindles, and irregular radiate forms; polyp armature not arranged in definite double rows.

Colony low, compact, more or less like a cauliflower. Total height about 45 mm, polypary expanse 60 mm. From a nar-

row base two very short stout stems arise. These divide into two or more short stout branches, which are marked by conspicuous transverse lines, and on which the lobes are compactly arranged. Lobes low and rounded, the largest 4 mm high and 4 mm wide. Polyps crowded mostly uniformly all over the lobes. Polyp about 0.7 mm long and about the same in width, and is at right or acute angle with a very short stalk about 0.45 mm long. Polyp armatures are large, thickly laid spindles with numerous large and high thorns. They are at most 0.35 mm long and 0.07 mm wide, not definitely arranged in double rows. A few smaller and smooth sclerites are visible in the inside of the polyp heads. Supporting bundle composed of several warty spindles at most 0.85 mm long, which do not project definitely beyond polyp head. On cortex of lobes are long warty spindles as large as 1.1 mm long. On upper cortex are simple spindles 0.4 to 0.5 mm long, with very regularly arranged warts. Basal cortex is with short stout spindles 0.3 to 0.6 mm long and 0.14 mm wide with high warts on one side, irregular bodies about 0.18 mm long with numerous, compact, high thorns on one side and other smaller ones of various shapes and dimensions with rounded or pointed projections. Cœnenchymal sclerites are spindles on the average 0.98 mm long and 0.17 mm wide with few low warts.

Philippine example (C–2100) from shallow reefs near Taytay Bay, Palawan, are yellowish brown.

NEPHTHEA LAEVIS Kükenthal.

Nephthea laevis KÜKENTHAL, Alcyonaria des Roten Meeres, Pola Expedition Wien (1913) 20, pl. 2, fig. 5.

Lobes slightly rounded or conical with rounded ends; polyps uniformly distributed with sclerites of supporting bundle not extending out; sclerites of polyps slightly greater outside than inside; polyp heads longer than wide; stalk not longer than polyp head; basal cortex with spindles and irregular thorny bodies.

Colony with a stout, columnar, or tapering stem about 110 mm high and 30 mm wide near base. Stout sterile stem exposed for the most part and gives rise only to few, widely separate, short or elongate branches that do not extend far from stem axis. Lobes situated singly on sterile stem or ends of short branches. They are hemispherical or slightly conical with rounded ends, 5 to 8 mm high and 5 to 6 mm wide. Polyps uniformly distributed and much crowded on lobes. Polyp body about 0.63 mm long and 0.5 mm wide, making an obtuse angle

with its short stalk. Sclerites of polyps outside slightly larger than those inside. Those on outside and lateral side are double rows, about six in a row, 0.18 to 0.2 mm long with prominent but widely separate thorns. Those on inside are flat sticks about 0.07 mm long with few low lateral warts. Supporting bundle composed of about eight spindles, the longest about 0.84 mm long with prominent warts, which do not protrude beyond polyp head. Cortex of upper stem and branches with spindles as long as 0.4 mm with regular high separate warts. At basal cortex spindles become larger, 0.5 mm long, with higher thorns, especially on one side. These are mixed with few irregular thorny bodies. In cœnenchyma are stout spindles as large as 1.05 mm long and 0.196 mm wide with few low warts.

Recorded from Djidda, Red Sea. The Philippine example (C–54) has no exact locality record.

NEPHTHEA BRASSICA Kükenthal.

Nephthea brassica KÜKENTHAL, Zool. Jahrb. Syst. **19** (1903) 165, pl. 7, fig. 1; pl. 9, figs. 57–59.

Polyps arranged uniformly in groups on more or less conical lobes; polyp heads not longer than wide; polyp stalk shorter than polyp head; polyp sclerites larger outside than inside; supporting bundle extends very little, if at all, beyond polyp heads; polyp sclerites four to five double rows; basal cortical sclerites spindles and irregular spinous bodies.

Colony low and wide. From a wide base one or more very short stems arise that directly divide into numerous short low branches on which the lobes are located. Lobes slightly rounded, but higher than broad, about 8 mm high and 5 mm wide. Polyps small, with short stalk, arranged in large groups around the lobes. Polyp head about 0.56 mm long and about the same in width. Polyp stalk very short, about 0.3 mm long. Sclerites of polyp on outer and lateral sides are straight or bent spindles as long as 0.23 mm, with many large prominent warts, four to five in the double rows. On the inner side the sclerites are slightly smaller, about 0.15 mm long, flat sticks with fewer and less-prominent warts. Sclerites of supporting bundle are spindles about 1 mm long with fine warts. Most of these adhere close to the dorsal side of the polyp heads. On basal cortex are stout spindles, 0.4 to 0.5 mm long, with many large branched spines, especially on one side, and irregular spinous bodies about 0.14 mm in diameter. Some irregularly branched spindles are

also found. In cœnenchyma are large stout spindles, about 1.5 mm long and 0.22 mm wide, with fine warts. These spindles may oftentimes be forked or branched, three-rayed or four-rayed.

Previously reported from Tonga Island. Philippine material from Puerto Galera Bay, Mindoro, in the Berlin Zoölogical Museum.

NEPHTHEA NIGRESCENS nom. nov.

Spongodes nigra KÜKENTHAL, Zool. Anz. (1895) 429.
Nephthya nigra KÜKENTHAL, Zool. Jahrb. 19 (1903) 152.

Polyps in small groups on lobes, which are long and pointed; polyp sclerites on the outside much larger than those on the inside; polyps seemingly as wide as they are high, standing at a right angle with a short stalk; cortical sclerites only spindles.

Colony upright and much branched. From a short sterile base, a medium high stalk arises. This gives off numerous branches on which the lobes are situated. Lobes rather long and pointed, about 9 mm long and 5 mm wide. The polyps are closely set on the apex of the lobes, but lower down, they are arranged in small groups. Polyps of medium size, about 0.7 mm high and 0.8 mm wide, making a right angle with a short stalk about 0.5 mm long. Polyp sclerites on the outside are in double rows, about five in a row, each about 0.2 mm long. Laterally and on the inside the sclerites are small sticks only about 0.08 mm long. Supporting bundle composed of about six spindles, the largest of which is about 0.9 mm long and does not protrude prominently beyond polyp head. Stem cortical sclerites are compact looking, strongly warted spindles about 0.9 mm long. In the canal walls are similar but slightly longer sclerites as long as 1.2 mm.

Color in alcohol blackish or dirty brown. The name *N. nigra*, as used for this species, is preoccupied.

Reported from Ternate. Philippine material was collected from Puerto Galera Bay, Mindoro.

NEPHTHEA QUERCUS Kükenthal.

Nephthya quercus KÜKENTHAL, Alcyonaria, Fauna Sudwest Australiens 3 Lief. 1 (1910) 47, pl. 2, fig. 14.

Supporting bundle does not protrude beyong polyp head; polyps arranged in groups, not uniformly distributed on lobes; sclerites of basal cortex spindles and irregular radiate bodies; lobes low, more or less rounded, not definitely higher than wide.

Colony low and wide, bushy in appearance. Total height of colony 60 mm with a polypary expanse of 90 mm. From a wide base, one or two short wide stalks arise. These almost at once divide to form numerous branches that subdivide into several short terminal twigs on which the numerous and small densely crowded lobes are located. Lobes rounded, about 4 to 6 mm high and 4 to 5 mm wide with rounded ends. Some may be conical. Polyps very small, seemingly densely crowded, but at places appear in groups. Polyps slightly longer than wide at times, although usually they are 0.5 mm long and 0.5 mm wide with short polyp stalk. Sclerites of polyp heads are large, curved or straight spindles in close double rows, five to seven in a row. They are about 0.28 mm long and provided with prominent, widely separate warts. A few sclerites that are not always seen, are present on the inner side. Supporting bundle sclerites at most 0.84 mm long and do not protrude beyond polyp head. Basal cortex with few stout spindles with high simple or branched warts, on the average 0.48 mm long and 0.08 mm wide, and numerous irregular spinous bodies of various shapes.

A Philippine example (C–2454), obtained from Small Balatero Cove, Puerto Galera, Mindoro, does not possess the typical coloration of the one described by Kükenthal.

NEPHTHEA CUPRESSIFORMIS Kükenthal.

N. cupressiformis KÜKENTHAL, Zool. Jahrb. **19** (1919) 153, pl. 7, fig. 7; pl. 9, figs. 40–44.

Lobes elongate, with polyps arranged in small groups; polyp head longer than wide; polyp stalk longer than polyp head; supporting bundle does not extend beyond polyp head; basal cortex with spindles and compact, irregular bodies.

Colony small and slender with a total height of 58 mm and a polypary expanse of 14 mm. The stem rises to about 30 mm before giving off short, slender, side branches. The polyps are in small groups, about five to seven in a group, on elongate lobes 6 to 10 mm high and 2 to 3 mm wide. Polyps with heads about 0.63 mm long and 0.56 mm wide at a right angle with a high stalk about 0.7 mm long. Polyp sclerites on the outside are spindles about 0.21 mm long with prominent warts arranged in double rows of about four in a row. Those on the sides are also spindles, but smaller, about 0.14 mm long. At

places they may be in double rows with as many as ten in a row. Sclerites on the inside are smooth sticks 0.028 mm long, without any special arrangement. Supporting bundle composed of six to seven spindles, at most 0.9 mm long, with widely separated warts. One or two of these may extend beyond the polyp head, although in most cases none of them does so. Sclerites of cortex are spindles 0.5 to 0.8 mm long and about 0.07 mm wide with high thorns on one side. At the extreme base the spindles are shorter, about 0.3 mm long with very high thorns, mixed with compact bodies 0.10 mm wide and 0.15 mm high with pointed projections. In the canal walls at base are spindles as large as 2.5 mm long and 0.35 mm wide with thickly set warts. Higher in the stem the spindles are much smaller and approach those of the cortex in size and appearance.

Previously reported from Palau Island. Philippine material (C–291) was obtained from Puerto Galera, Mindoro.

NEPHTHEA AMENTACEA Studer.

N. amentacea TH. STUDER, Mitth. geogr. Ges. und naturh. Mus. Lubeck (2) Heft 7 u. 8 (1894) 123.

Polyps in close groups all over elongate, fingerlike lobes; polyps cup-shaped, not longer than wide; polyp stalk longer than polyp head; sclerites of polyps slightly larger outside than inside; sclerites of supporting bundle do not protrude beyond polyp head. On basal cortex are spindles with high warts on one side and other sclerites.

Colony small. A main stem arises from the base and divides into a number of short branches on which the lobes are located. Lobes elongate, fingerlike, on the average about 7 mm high and 4 mm wide. Polyps arranged in groups, as many as six in a group, the groups not arranged in transverse rows on lobes. Polyp heads about 0.56 mm long and 0.7 mm wide, forming an acute or a right angle with the polyp stalk, which is slender, about 6 mm long. Sclerites in polyp head slightly larger outside than inside. Those on the outside and lateral sides are sticks about 0.21 mm long with prominent warts, in double rows of five to six. On the inner side, polyp sclerites are smaller, about 0.13 mm long, with less-prominent warts. Sclerites of supporting bundle composed of about six spindles that do not protrude beyond the polyp head. Most of them are about 0.7 mm long although a few may be much longer. In stem cortex

are spindles as much as 0.6 mm long and 0.06 mm wide with simple warts, smaller but thicker spindles about 0.25 mm long with high branched warts, especially on one side, and modified spindles, three-rayed or four-rayed sclerites. In the cœnenchyma are simple low-warted spindles 0.5 to 0.7 mm long and 0.07 to 0.11 mm wide.

Previously reported from Sulu Island (Philippines). The material in hand (C–306 and C–278) was obtained from the shallow reefs in Puerto Galera Bay, Mindoro.

NEPHTHEA GLOBULOSA (May).

Spongodes globulosa MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 167.

Polyps uniformly distributed on rounded lobes. Polyp head not longer than wide; polyp stalk not longer than polyp head; sclerites of polyps larger outside than inside; sclerites of supporting bundle protrude prominently beyond polyp head. Cortex only with spindles.

Colony large, low, and spreading. From a wide base two short main stems arise, which at once divide to form numerous branches on which the lobes are densely crowded. Lobes of various dimensions, rounded, but not low. The majority are 6 mm high and 5 mm wide, although some are very high and others very low. Polyps uniformly distributed on lobes. Polyp head at a right angle to polyp stalk. Polyp stalk about 0.35 mm high; polyp head is about 0.42 mm long and 0.6 to 0.7 mm wide. Sclerites of polyp head are spindles about 0.28 to 0.3 mm long and 0.028 to 0.03 mm wide, with prominent high warts in double rows of four to five in a row. On the inner side, sclerites are smaller sticks about 0.07 mm long with less-prominent warts. Supporting bundle well developed, consisting of about eight sclerites which may grow as long as 1.8 mm with prominent warts, two or more of which extend beyond polyp head. In the cortex of the branches are spindles as long as 1.3 mm and 0.12 mm wide with prominent warts. At the base the spindles are shorter, on the average about 0.7 mm, but with longer warts. Cœnenchymal sclerites are also spindles, but with very low warts. In the branches they are very slender, 1.2 mm long and 0.07 mm wide, while at the base they are thick, about 1.7 mm long and 0.28 mm wide.

Recorded from the South Sea. Philippine material (C–2149 and C–2112) was obtained from Taytay Bay, Palawan.

NEPHTHEA ELONGATA (Kükenthal).

Spongodes elongata KÜKENTHAL, Zool. Anz. (1895) 429.

Polyps uniformly distributed on conical lobes that are rounded at tip; supporting-bundle sclerites extend beyond polyp head; sclerites of polyp head slightly larger outside than inside; no transverse sclerites found on polyp head.

Colony small with a rather stout stem. This gives off two or three short branches on which lobes are located. Lobes slightly elongate, conical, rounded at tip, 5 to 6 mm high and 3 mm wide. Polyps uniformly distributed all over lobes. Polyp head not longer than wide and polyp stalk shorter than polyp head. Polyp head about 0.4 to 0.5 mm long and just as wide. Polyp stalk about 0.3 mm high. Sclerites of polyps on outer and lateral sides in double rows, six in a row, about 0.25 mm long and 0.042 mm wide, with prominent warts. Those on the inner side are slightly smaller, at most 0.098 mm long. Supporting bundle composed of six long-warted spindles, reaching 1.4 mm in length. One or two of these extend slightly beyond polyp head. Sclerites of basal cortex are spindles, 0.4 to 0.7 mm long and about 0.08 to 0.1 mm wide, with high simple warts. In addition are shorter, stouter spindles, about 0.18 mm long and 0.07 mm wide, with many branched spines on one side. In the outer cœnenchymal walls are simple spindles, smooth looking with few warts, about 0.42 mm long and 0.07 mm wide. Many of these are branched, forked, or four-rayed, etc. In the inner cœnenchyma of base are stout spindles, 0.98 to 1.3 mm long and 0.12 mm wide, with low small warts.

Reported from Ternate. Philippine material (C–2091) has no exact locality recorded.

NEPHTHEA PACIFICA Kükenthal.

N. pacifica KÜKENTHAL, Zool. Jahrb. Syst. 19 (1903) 158.

Polyps uniformly distributed on elongate fingerlike lobes; polyp sclerites decidedly larger outside than inside; one or more sclerites of supporting bundle project beyond polyp head; large transverse sclerites present between the smaller sclerites in double rows.

Colony rigid, small or large. Several stems arise from a common base; main stems divide into two or more large branches on which the lobes arise. Sometimes, however, tertiaries are given off on which the lobes are located. Lobes elongate,

as large as 10 mm high and 6 mm wide. Polyps crowded, with stalk 0.5 mm long and head 0.5 mm high and 0.8 mm wide. Polyp sclerites spindles about 0.24 mm long and 0.025 mm wide with few prominent warts. Under these are smaller, almost smooth, sclerites arranged in double rows. On inner side of polyps are still smaller, short, tiny sticks irregularly disposed. Supporting bundle well developed, composed of six to ten sclerites, usually 0.8 mm long and 0.04 mm wide, although a few may be much longer, at most 1.4 mm long. In basal cortex are short stout spindles, 0.4 to 0.6 mm long and 0.05 to 0.1 mm wide, with fine warts. Under these are small but much more heavily warted spindles especially on one side where high branched thorns are present. These are 0.3 to 0.6 mm long and 0.08 mm wide, exclusive of spines. Among these are small, high thorny, irregular bodies about 0.12 mm in diameter. In cœnenchyma are large, massive, straight or bent spindles, 1.6 mm long and 0.25 mm wide, with many fine closely set warts.

Reported from Viti Island (Pacific Ocean). Philippine material (C–2110) was obtained from shallow-water reefs near Taytay, Palawan.

NEPHTHEA DEBILIS (Kükenthal).

Spongodes debilis KÜKENTHAL, Zool. Anz. (1895) 431.

Polyps arranged in groups on elongate lobes, but groups are not in transverse rows; supporting-bundle sclerites extend slightly beyond polyp head; polyp head not longer than wide; polyp stalk shorter than polyp head; sclerites of polyp head smaller inside than outside; sclerites in double rows, five to six in a row.

Colony tall. Polyps in groups on elongate lobes situated on small terminal branches and on side branches. Lobes on the average 11 mm long and 5 mm wide, although many are shorter and more rounded. Polyp groups are not in transverse rows. Polyp head about 0.6 to 0.7 mm wide and 0.42 mm long at an obtuse angle with the polyp stalk, which is about 0.39 mm high. Sclerites on outer side of polyp head are 0.28 to 0.3 mm long with prominent warts, in double rows, five to six in a row. Sclerites on inner side are small sticks, at most 0.14 mm long. Supporting bundle composed of about ten warty spindles, which may grow as long as 1.2 mm. Sclerites of upper cortex are spindles, at most 0.49 mm long and 0.084 mm wide, with coarse but seemingly high warts, especially on one side. At the base

the cortical sclerites become shorter and thicker with numerous high thorns on one side, as well as irregular very thorny sclerites. Cœnenchymal sclerites are stout spindles with low warts. The largest of these are 1.5 mm long and 0.21 mm wide.

Recorded from Ternate. Philippine material (C–315) was obtained from the shallow reefs in Puerto Galera Bay, Mindoro.

NEPHTHEA CEYLONENSIS (Thomson and Henderson).

Nephthya chabrolii var. *ceylonensis* THOMSON and HENDERSON, Alcyonaria, Rep. on Pearl Oyster Fisheries Manaar, Supp. Rep. 20 (1905) 275.

Polyps arranged in groups on elongate, fingerlike lobes. Polyp head not longer than broad; stalk of polyps not longer than polyp head; sclerites of polyp head outside slightly larger than those inside; sclerites of supporting bundle protrude decidedly beyond polyp head.

Colony bushy, with a total height of 70 mm, and the polypary with a total expanse of 55 mm. Main stem very short, which at once divides into two main branches on which the side branches arise. Lobes numerous and crowded, elongate, fingerlike, on the average 10 mm high and 4 mm wide. Polyps single or in small groups all over lobes and not crowded. Polyp head 0.7 to 0.9 mm wide and 0.56 mm long at a right angle with a very short stalk 0.56 mm high. Sclerites on outer and lateral sides are spindles 0.25 to 0.3 mm long with very large, widely separate warts, arranged in double rows, five to six in a row. Those on the inner side are slightly smaller, about three to four in a row. Supporting bundle well developed, composed of long spindles at most 1.50 mm long, especially warty at the middle. Cortex of branches and lobes with slender spindles as large as 1.05 mm long and 0.11 mm wide. Sclerites of base cortex are mostly irregular or star-shaped spinous bodies at most 0.14 mm wide and 0.21 mm high. In addition a few spindles are found. Some of these are short and thick, 0.56 mm long and 0.14 mm wide, with high branched thorns on one side, while others are as much as 0.91 mm long and 0.12 mm wide, with high warts also on one side. In the cœnenchymal wall are stout spindles at most 1.12 mm long and 0.21 mm wide with low warts. The majority, however, are much smaller and smoother. Many are triradiate or four-rayed.

Reported from Gulf of Manaar. Philippine material (C–2149) was obtained from Pabellones Island, at the mouth of Taytay Bay, Palawan, and (C–2119) from reefs near Taytay.

NEPHTHEA ZANZIBARENSIS Thomson and McQueen.

N. zanzibarensis THOMSON and MCQUEEN, Journ. Linn. Soc. 31 (1908) 59.

Polyps arranged in groups on elongate lobes, but groups are not arranged in transverse rows; polyp head not longer than wide and stalk shorter than polyp head; sclerites of polyp heads larger outside than inside; sclerites of supporting bundle extend prominently beyond polyp head.

Colony low, bushy in appearance. Stem very short and gives rise close at the base to four branches that in turn divide into numerous short branchlets on which the lobes are thickly crowded. Lobes even arise near base of main branches. Lobes elongate, cylindrical, and slender, on the average 12 mm long and 3 mm wide. Polyps arranged in definite groups of four or more, but the groups are not arranged in transverse rows. Polyp heads about 0.7 mm long and 0.84 mm wide in an acute angle with a short stalk 0.56 mm high. Sclerites on polyp head in double rows of more than eight in a row. These are spindles about 0.18 mm long with few but large warts. Sclerites on the inside of polyp head and stalk are numerous flat sticks about 0.07 mm long. Supporting bundle composed of six to seven spindles as long as 1.2 mm, with fine warts. Sclerites of cortex of branches are spindles, on the average 0.42 mm long, with high thorns, mixed with smaller spindles, 0.25 mm long, with fewer and lower warts. At the base the sclerites transform into irregular highly spinous bodies, on the average 0.17 mm in diameter. A few spindles similar to those higher in the stem are also found. In the cœnenchyma are smooth, pointed spindles of various sizes. Sclerites are present in the tentacles, contrary to what has been said about the type of Thomson and Henderson.

Philippine material (C–2216) was obtained from shallow reefs at Batas Island, on the east coast of Palawan, and (C–278*a*) from Puerto Galera Bay, Mindoro.

NEPHTHEA DIGITATA (Wright and Studer).

Spongodes digitata WRIGHT and STUDER, Challenger Report 31 (1889) 193, pl. 36, figs. 2*a*, 2*b*.

Polyps in small groups on lobes; lobes longer than broad; one or more sclerites of supporting bundle extend beyond the polyp head; polyp stalk longer than polyp head; polyp groups not arranged in transverse rows on lobes.

Colony low, wide and bushy in appearance. From a common base two or more stout stems arise. These stems give rise at different levels to many short branches on which the lobes arise. Lobes elongate, about 10 mm high and 6 mm wide, more or less pointed at end. Polyps in small groups on lobes, not closely set, and diverging on all sides. Polyp head stands at a right angle with polyp stalk. Polyp head about 0.98 mm wide and 0.42 mm wide, while polyp stalk is about 0.77 mm long. Sclerites of polyps on outer and lateral sides are straight or bent spindles, about 0.28 mm long, with rather prominent warts. They are arranged in four or five converging double rows. On inner side of polyp are very numerous tiny, flat, smooth sticks about 0.07 mm long, densely packed together. Supporting bundle composed of five or more spindles with fine warts which may grow to 1.5 mm long. One or more project beyond polyp head. On basal cortex are only warty spindles which may be as large as 0.98 mm long and 0.084 mm wide. In cœnenchyma are stout low-warted spindles as large as 1.5 mm long and 0.22 mm wide. In life the main stem is drab with a tinge of lilac, polypary smoky.

Recorded from reefs off the coast of Cebu, Philippines. The most-abundant form at Puerto Galera Bay, Mindoro, found in water between 10 and 25 meters deep.

NEPHTHEA ARMATA Thomson and Henderson.

N. armata THOMSON and HENDERSON, Proc. Zool. Soc. London (1906) 422, pl. 27, fig. 4.

Polyps arranged in very small groups of threes or fours, which are more or less in transverse rows on very long, slender, fingerlike lobes; tips of sclerites of supporting bundle smooth; polyp sclerites at most 0.5 mm long.

Unlike Thomson and Henderson's type the colony is large, with a total height of 100 mm and an expanse of 80 mm. Colony consists of one long main stem, which gives rise to numerous branches, three or four of which may be given off at one level. Main branches divided into secondaries and tertiaries where lobes are located. Lobes slender, at times reaching a length of 11 mm and a width of 3 mm. Polyps on lobes in groups of threes or fours, the groups somewhat widely separate. Polyp heads shorter than wide and polyp stalk longer than polyp head. Sclerites of polyp head short and stout spindles arranged in double rows with coarse warts, usually about

0.3 to 0.5 mm long. Supporting-bundle sclerites four to five, usually about 0.8 mm long with smooth ends, one or more of which may project beyond polyp head. Sclerites of cœnenchyma of lobes are long, finely warted sclerites, 1 to 1.4 mm long and 0.06 to 0.08 mm wide. Cœnenchymal sclerites of base but few large spindles about 1.5 mm long and 0.18 mm wide. Cortical sclerites of base are heavily warted spindles, 0.4 to 0.7 mm long and 0.08 to 0.1 mm wide. On the inner cortex are numerous warty spindles, 0.4 to 0.9 mm long and 0.08 to 0.1 mm wide, with many high branched spines on one side.

Reported from Zanzibar. Philippine material (C–2149) was obtained from Puerto Galera Bay, Mindoro.

Genus DENDRONEPHTHYA Kükenthal

Dendronephthya KÜKENTHAL, Zool. Jahrb. Syst. 21 (1905) 526.
Dendronephthya SHANN, Proc. Zool. Soc. London (1912) 518.

The greater bulk of the species now included under this genus formerly belonged to the genus *Spongodes,* which all workers used until 1905. The genus *Spongodes,* based on *Spongodes celosia* as type, was established by Lesson in 1834. In 1846, however, Dana, without any apparent reason, changed the name to *Spoggodia,* under which he included, in addition to *Spongodes celosia* and a new variety *Spongodes celosia* var. *arborescens, Alcyonium floridum* of Asper. Gray in 1859 at first included *Spoggodia* under *Nephthea,* but in 1862 accepted it as a valid genus and divided it into the subgenera *Spoggodes* and *Spoggodia.* Wright and Studer (1899) used the name *Spongodes* and divided it into Spicatæ, Glomeratæ (*Spoggodes* of Gray), and Divaricatæ (*Spoggodia* of Gray). Most of the Spicatæ of Wright and Studer are now ranked under the genus *Nephthea.* Holm (1895), while contributing much to the knowledge of the group, would not separate *Spongodes* from *Nephthea.* He used *Spongodes* as the generic name and divided it into four subgenera; namely, *Nephthea, Panope, Spongodia,* and *Spongodes.* In 1896, Kükenthal definitely established the difference between *Nephthea* and *Spongodes* and divided the latter into the two subgenera *Spongodes* and *Spongodia.* Later both Holm and Kükenthal felt the need of elevating *Spongodia* from the rank of a subgenus to that of a genus. This was done by Kükenthal in 1905, but to avoid confusions and to follow the International Rules of Nomenclature promulgated in that year

he discarded *Spongodes* and gave the genus a new name, *Dendronephthya.* The name *Spongodes* could not be retained, as the type of Lesson, *S. celosia,* is a species of *Nephthea. Spongodia,* as first used, was synonymous with *Spongodes.* Thus Kükenthal also dropped it and used the new name *Stereonephthya* instead.

The difficulty of working out any collection of *Dendronephthya* lies in the enormous number of species of the group which differ from one another only in very minute characters. Kükenthal (1905), in his revision of the family Nephthyidæ, enumerated and described in detail no fewer than eighty-seven species; and Henderson (1909), in working out the alcyonarians of the Indian Ocean, described another series of sixty species, all said to be different from those described by Kükenthal and previous workers. Kükenthal (1910), in working out the Michaelsen-Hartmeyer collection from southwestern Australia, described one new species and two new varieties, and in 1911 he described four other species and one variety. Finally, in 1922, Sherriffs, working out the *Dendronephthya* of the Siboga Expedition, gave an excellent treatise on the genus, promulgated the very useful "anthocodial grade and formula" system, and described three additional new species. Such an enormous number of species within a genus makes it very unwieldy. Such being the case, several workers with whom I have been personally in contact are of the opinion that the genus *Dendronephthya* should be divided into three distinct genera. This plan is worth while considering as there are sufficient differences among the three groups within *Dendronephthya* (Glomeratæ Divaricatæ, and Umbellatæ) ; just as there are between *Dendronephthya* and *Stereonephthya.* I shall not be surprised if in five or ten years from now some one finds sufficient courage to put this plan into practice.

The genus *Dendronephthya* is usually defined to include all Nephthyidea with bushlike or branched appearance whose polyps are always provided with supporting bundles and always appear in groups or bundles. In *Nephthea* the polyps are always arranged in lobes or catkins, while in *Stereonephthya* the polyps usually arise singly directly from the stalk, main branches, or twigs, never forming groups, bundles, or lobes.

Following the example of recent workers on this genus, I am using the three main groups, Glomeratæ, Divaricatæ, and Umbellatæ. The definition of these groups is included in the key.

To facilitate the use of the specific descriptions of the various species, I explain here the terms most commonly used in the diagnosis of the species.

Anthocodial sclerites.—These sclerites are usually in eight double rows, extending from the basal to the apical portions of the polyp heads. In certain cases, however, there may be only five or six double rows, the two or three double rows situated ventrally—that is, on the inner side of the polyp head—may be absent. The sclerites in a double row are designated by the term "point sclerites." It is taken for granted in this paper that species with more point sclerites are more primitive than those in which there are less. Point sclerites may all be of the same size and shape. In the case of the more highly developed species, however, one or both of the outer point sclerites (towards the apical end of the polyp head) in a double row may be much larger than the rest and may project for some distance beyond the base of the tentacles. Following Sherriffs, I am designating the larger sclerites as *P* and the smaller, *p*.

Crown sclerites.—When there are numerous point sclerites (four or more in a row) they are only the ones found on the polyp head proper. In cases, however, where there are only very few of them (three or less in a row), some sclerites are present, lying more or less horizontally at the base of the polyp head. These are usually in two or three rows and do not form a part of the double rows of anthocodial sclerites. These are called "crown sclerites" and are designated as *Cr.* Species with crown sclerites are assumed to be phylogenetically higher than species without them.

Supporting bundle.—I am using this term in place of the German word "Stützbundel;" it is usually abbreviated as S.B. The term denotes a group of well-developed sclerites located on the external (dorsal) side of the polyp stalk. In the majority of cases the supporting bundle is composed of few very large spindles, one or several of which may extend for a distance beyond the external angle formed by the polyp stalk and polyp head. In some cases, however, the sclerites composing the bundle are small when they cover a wide portion of the stalk base and converge apically into a point. Such a supporting bundle is called "ensheathing" in type. A supporting bundle composed of few but very large sclerites is said to be "strong" and is considered more highly developed than one with numerous but small sclerites, called "weak."

Accessory sclerites.—I use this term to denote few or many small or medium-sized sclerites sometimes present on the internal (ventral) side of the polyp stalk.

Intermediate sclerites.—These are one or two pairs of very small sclerites between the double rows of anthocodial sclerites and may be seen just below and between the bases of the tentacles. Oftentimes they are not easily discernible.

Foliaceous branches.—In many species of *Dendronephthya* two or more of the lowest branches are much flattened, arched, and directed ventrally. Sometimes they form a complete ring or collar all around the stalk, marking the boundary between the sterile stalk and the polypary.

The polyp stalk is said to be "short" when it is about 1 mm long or shorter. It is "long" when it is about 2 mm high.

Sherriffs (1922) has adopted his "anthocodial grade and formula," which I have found very useful. The formula, together with the description of the habitus and branching and the type of sclerites found in the branches and stalk, enables one to locate just about where a specimen lies in the complex system of species in a group.

Sherriffs has reduced all of the species to six anthocodial grades, depending upon the number and differentiation of point sclerites and the presence or absence of crown sclerites. As has been said previously, the ones with more numerous point sclerites and without crown sclerites are considered more primitive than those with fewer point sclerites and with well-developed crown sclerites. The following are the various anthocodial grades:

Grade I.—Each point composed of very numerous small sclerites, usually all of the same size. The number in a row may be eight to twelve or sometimes many more. Crown sclerites absent.

Grade II.—Each point composed of six to eight pairs of sclerites. They are usually medium and uniform in size. Crown sclerites absent.

Grade III.—Each point composed of four to six pairs, the outermost pair somewhat more developed, although not projecting out of the polyp head. Crown sclerites absent.

Grade IV.—Each point composed of four to five pairs of rather large sclerites, one or both of the outermost much larger and projecting out of the polyp head. Crown sclerites absent.

Grade V.—Each point composed of three pairs only, one or both of the outermost being much longer, stronger, and project-

ing definitely beyond polyp head. Two or three rows of crown sclerites present.

Grade VI.—Each point composed of only one pair of large, strong, and decidedly projecting sclerites. Two or three rows of crown sclerites. In some cases there are one or two pairs of very tiny intermediate sclerites between the rows of point sclerites.

I. GLOMERATÆ

This group includes all species in which the colony is only slightly branched or, when much branched, the branches stout and usually hidden by polyp groups. The polyps are in groups which in turn form closely set rounded bunches giving the colony an irregular external surface.

a^1. Point sclerites of polyp head more on outer (dorsal) rows than on lateral.
  b^1. Crown sclerites present (on ventral only).... *D. guggenheimi* sp. nov.
  b^2. Crown sclerites absent.
    c^1. Very few, if any, sclerites on ventral side of polyp head. *D. moseri* sp. nov.
    c^2. Numerous small sclerites on ventral side............ *D. fusca* (Studer).
a^2. Point sclerites equal all around polyp head.
  b^1. Crown sclerites absent.
    c^1. Some point sclerites project out of polyp head.
      d^1. Polypary not flattened.
        e^1. Colony low, with short sterile stalk and prominent side branches.
          f^1. All outermost point sclerites project out slightly. *D. gigantea* (Verrill).
          f^2. Only outermost point sclerites of lateral rows project decidedly .... *D. spinifera* (Holm).
        e^2. Colony tall and columnar with very short side branches. *D. roemeri* Kükenthal.
      d^2. Polypary flattened laterally........................ *D. aculeata* Kükenthal.
    c^2. No point sclerites project beyond polyp head. *D. hicksoni* (Kükenthal).
  b^2. Crown sclerites present.. *D. semperi* (Studer).

II. DIVARICATÆ

This group includes all species with a profusely branched polypary. The branches are usually very long and slender and the polyp bundles are at the ends of small, slender, terminal twigs, although these are not always on the surface of the polypary. In most cases the branches are so located and directed as to give the polypary a uniform contour. A great many of the Divaricatæ have the polypary flattened laterally.

a^1. Crown sclerites absent.
  b^1. Polyp stalk very short (less than 1 mm) .... *D. griffini* sp. nov.
  b^2. Polyp stalk slender.
    c^1. Polyp stalk about 2 mm; point sclerites six to eight in a row. *D. microspiculata* (Pütter).
    c^2. Polyp stalk about 2 mm; point sclerites five in a row. *D. divaricata* (Gray).
a^2. Crown sclerites present.
  b^1. Polypary not flattened laterally .... *D. radiata* Kükenthal.
  b^2. Polypary flattened laterally.
    c^1. Polyp stalk long.
      d^1. Polypary with uniform contour .... *D. pütteri* Kükenthal.
      d^2. Polypary without a uniform contour. *D. cervicornis* (Wright and Studer).
    c^2. Polyp stalk short.
      d^1. Polypary with an oval outline .... *D. gracillama* Kükenthal.
      d^2. Polypary with an irregular outline .... *D. flammea* Sherriffs.

III. UMBELLATÆ

This group includes all species whose polypary is so branched that all terminal twigs are in umbellike or corymblike groups, the heads of the umbels being formed by the bundles or groups of polyps. Here most of the polyp groups are on the outer surface of the polypary.

a^1. No point sclerites project beyond polyp head.
  b^1. Umbels form hemispherical groups.
    c^1. Sclerites of supporting bundle extend beyond polyp head. *D. repens* Kükenthal.
    c^2. No sclerites of supporting bundle extend beyond polyp head. *D. manyanensis* sp. nov.
  b^2. Umbels do not form hemispherical groups.
    c^1. Accessory sclerites present on inner side of polyp stalk. *D. brevirama* (Burchardt).
    c^2. No accessory sclerites on ventral (inner) side of polyp stalk. *D. florida* (Esper).
a^2. Some outer point sclerites project out of the polyp head.
  b^1. Stalk of colony tall and columnar.
    c^1. Lower branches not foliaceous .... *D. anguina* (Wright and Studer).
    c^2. Lower branches foliaceous .... *D. malaya* sp. nov.
  b^2. Stalk of colony short.
    c^1. Lower branches not foliaceous .... *D. rubra* (May).
    c^2. Lower branches foliaceous .... *D. umbellata* (Wright and Studer).

I. GLOMERATÆ

DENDRONEPHTHYA GUGGENHEIMI sp. nov. Plate 2, fig. 4; Plate 5, fig. 1.

Glomerate, with a short stalk and numerous short or long stout branches; polyps in small crowded groups on stem and in

large rounded lobelike groups on sides and ends of branches; polyp stalk very short; anthocodial armature two to eight in a row, none extending out; more on outer than on lateral and inner sides; crown sclerites only on inner side of the polyp head; formula:

$$II = 2\text{–}8\ p + 2\ Cr\ \text{(on ventral only)} + \text{medium S.B.}$$

Colony low and bushy. Stalk very short, giving out at once numerous slender or stout branches at different levels. Lower branches not foliaceous. Polyps in small but crowded groups on stem, but at branches, especially at their ends, they are in large rounded groups. Polyps more or less conical in shape, about 1.2 mm long and 0.8 mm wide, making a very acute angle with a very short polyp stalk. Anthocodial armature in eight very close and acute double rows. There are eight sclerites in each of the outer rows, three to seven on the four lateral rows, and only one or two on the inner double rows. Sclerites not uniform in size. Some are as large as 0.7 mm long and 0.056 mm wide. No crown sclerites visible on outer side of polyp head, but two to three rows of small crown sclerites are oftentimes seen on the inner side. All polyp sclerites provided with fine-pointed warts and all are light pink. Supporting bundle composed of six to eight spindles, the largest of which may be 3.5 mm long and 0.24 mm wide, extending only for a very short distance beyond polyp head. All sclerites of supporting bundle ivory white, with fine warts. On cortex of upper stem and branches are slender spindles arranged more or less irregularly. The largest are about 2.4 mm long and 0.13 mm wide, the smallest 0.56 mm long and 0.04 mm wide, all provided with small rounded warts. Mixed with the spindles and deeper in the cortex are more-numerous, small, slender sticks, 0.07 to 0.24 mm long, with very few warts.

Type: No. C–5001, University of the Philippines zoölogical collection, collected from Puerto Galera Bay, Mindoro. Polypary pinkish, stalk yellowish in alcohol.

DENDRONEPHTHYA MOSERI sp. nov. Plate 5, fig. 2.

Glomerate, with narrow, short, sterile basal stalk which gradually enlarges to form the main stalk and short fingerlike branches on which the groups of polyps are situated; polyp groups widely separate at stalk but much crowded together on branches; polyps at right angle with very short polyp stalk;

anthocodial sclerites small, in six double rows only, four to twelve in a row; crown sclerites absent; supporting bundle poorly developed; formula:

$$\text{II} = 4\text{–}12 \text{ p} + 0 \text{ Cr} + \text{weak S.B.}$$

Sterile stalk very short, hardly appreciable, which continues upward without any visible interruption to a gradually enlarging stem. This, after a short distance, gives rise to two or more main branches that in turn give off a number of short finger-like secondary branches at different levels. Lower portions of stalk entirely free from branches. Polyps in distinct groups of various numbers that are far apart on stem and main branches. On smaller branches, however, polyp groups are closely crowded, allowing no appreciable spaces between them. Polyp heads about 1 to 1.6 mm long and 0.8 mm wide, making an almost right angle with a short polyp stalk about 0.8 mm high. Anthocodial armature peculiar. There are, instead of the regular eight double rows, only six double rows of sclerites, the inner (ventral) double rows being absent. On the four dorsal double rows, there are eight to twelve small uniform sclerites in a row, while on the two ventrolateral there are only four to six in a row. Sclerites with fine warts, about 0.49 mm long, although the outermost of the four dorsal double rows are larger and slightly longer, about 0.84 mm long, and enlarged at the slightly protruding end. At times vestiges of the two ventral double rows are present in the form of few, tiny, irregularly disposed sclerites not exceeding 0.15 mm in length. Crown sclerites absent. Supporting bundle is of the ensheathing type, composed of six to eight spindles, one or two of which are about 1.8 mm long, extending only very slightly beyond polyp head. On cortex of branches and main stem are simple spindles, 1.2 to 2.2 mm long and 0.09 to 0.2 mm wide, with fine warts. They are more or less densely crowded together. Towards basal part of stem the spindles become shorter and develop higher warts. At extreme basal portion of stalk are irregular or branched spindles or clubs, ranging from 1.4 to 0.35 mm in length, with prominent projections. In cœnenchymal walls are few, tiny, weak-looking sticks, at most 0.28 mm long and 0.04 mm wide, with few fine warts.

Type: No. C–5002, University of the Philippines zoölogical collection, obtained from shallow water of Puerto Galera Bay, Mindoro. Four colonies; the largest with a total height of 70

mm and a polypary expense of 40 mm. Base white, stalk and branches light pinkish yellow; the polyps geranium pink due to color of anthocodial and supporting bundle sclerites.

This form definitely is to be reckoned under the *savignyi* group of Glomeratæ of Kükenthal. The habitus and spiculation, however, are different from any other glomerate *Dendronephthya* so far described.

DENDRONEPHTHYA FUSCA (Studer).

Spongodes fusca STUDER, Mitt. geogr. Ges. naturh. Mus. Lubeck (2) Heft 7 u. 8 (1894) 126, 127, pl. 4 fig. 3; pl. 6, fig. 5.

Glomerate, with slender and much-branched colony with polyps in separate bundles mostly on terminal twigs; polyps at right angle with short stalk; anthocodial armature in indistinct double rows, six in a row externally and three to four laterally; only small sticks present on inner side of polyp head; no crown sclerites present; supporting bundle medium sized; formula:

$$\text{III} = 3\text{–}6\ \text{P} + 0\ \text{Cr} + \text{medium S.B.}$$

Colony composed of a short trunk and a number of main stems, with brittle-looking cortex that divides to form side branches. From the side branches slender terminal twigs about 6 mm high arise. Polyps rounded, about 0.7 mm high and just as wide, making a right angle with polyp stalk about 0.7 mm high. Polyps in bundles not closely crowded on terminal twigs. On outer side of polyps are spindles about 0.34 mm long with strong warts arranged in irregular double rows, about six in a row. On the lateral sides the spindles are smaller, about 0.24 mm long, only three to four in a row. On inner side of polyp head are numerous small sclerites about 0.07 mm long with few warts. Similar sclerites are found in the tentacles. Supporting bundle composed of a number of warty, straight or slightly bent spindles that form a sheath on the polyp stalk. A pair of these extends out of the polyp head. A few of the supporting bundle sclerites may be as long as 2 mm and extend out for about 0.3 mm beyond the polyp head. On cortex of upper branches are numerous bent spindles extending in all directions, about 0.6 mm long and 0.08 mm wide, with many thorny warts. At lower cortex these spindles become more compact. In addition to them, short, clublike, and radiate bodies are present. In canal walls of branches are spindles 0.53 mm long with very long, oftentimes branched, warts. In stalk cœnenchyma are spindles 0.55 mm

long and 0.08 mm wide with widely separate, broad, and low warts. In addition few irregular radiate bodies may be present. Color light brown.

This description is based on a small specimen found in the Berlin Museum, which forms a part of the one described by Studer. Material obtained from Sulu Island. Type is at the Lubeck Museum.

DENDRONEPHTHYA GIGANTEA (Verrill). Plate 5, fig. 3.

Spongodes gigantea VERRILL, Bull. Mus. Comp. Zool. Cambridge (1864) 40.

Dendronephthya gigantea KÜKENTHAL, Zool. Jahrb. 21 (1905) 540, pl. 25, fig. 6.

Glomerate, with polyps forming large rounded masses that hide the underlying main stem and branches; lower branches slightly foliaceous; polyps more or less oval in shape, at obtuse angle with a short polyp stalk; anthocodial armature in eight double rows, about five or six in a row, all outermost being larger and projecting slightly only beyond polyp head; crown sclerites absent; supporting bundle exceptionally well developed; formula:

$$\text{III} = (1\text{ P} + 4\text{–}5\text{ p}) + 0\text{ Cr} + \text{very strong S.B.}$$

Basal stalk very short, almost invisible. This at once gives off several stout main branches that, together with the main stem, are fully covered with a number of large rounded lobes formed by the polyps. Polyps more or less oval, 0.7 mm long and 0.9 mm wide, making a very obtuse angle with a short stalk less than 1 mm long. Anthocodial armature in the form of eight double rows, about five to six in a row. The sclerites are usually about 0.3 mm long, but the outermost, one or both in each double row, are longer and thicker and may extend prominently beyond polyp head. Crown sclerites absent. Supporting bundle exceedingly well developed, composed of four or more sclerites, one or two of which are as long as 4 mm and covered with prominent warts. They extend far out of the polyp head. On the cortex of upper stem and branches are large spindles, as long as 4 mm, covered with large, blunt, truncate, oftentimes compound warts. They lie transversely for the most part. On lower stem cortex are smaller, heavily warted spindles, 0.3 mm long on the average. In canal walls are few, large, thick, sparsely warted spindles about 0.8 mm long and

mixed with numerous smaller and thinner spindles about 0.3 mm long.

DENDRONEPHTHYA SPINIFERA (Holm). Plate 5, fig. 4.

Spongodes spinifera HOLM, Zool. Jahrb. Syst. 8 (1895) 37, pl. 2, fig. 20–22.

Glomerate, with short, stout, upper branches and expanded, foliaceous, lower branches; with numerous groups of polyps closely crowded, covering practically all the stem and branches; polyp stalk medium in length; anthocodial armature four to five in a row, with the outermost of the lateral rows more prominent and extending out; no crown sclerites; formula:

$$\text{III} = (1\text{ P} + 3\text{–}4\text{ p}) + 0\text{ Cr} + \text{strong S.B.}$$

Colony bushy, stout and low. From a base two or more columnar, stout stems arise that give off only few, stout, rounded branches. Near the base a narrow, expanded, leaflike branch forms an almost complete collar around the stem. Polyps in small or large groups. The groups on main stem at times may be far apart but usually they are close together and leave no portion of the main stem and branches, especially the ends of branches, exposed. Polyps about 0.8 mm wide and about the same in length, standing in a very obtuse angle with a stalk from 0.7 to 1 mm in length. Anthocodial armature in eight double rows, four to five in a row. The outermost sclerites, especially of the lateral rows are larger, measuring as much as 0.8 mm in length, and extending far out of the polyp head. The other sclerites are smaller, on the average about 0.5 mm long. All anthocodial sclerites are yellowish, with widely separate, low, conical warts. No crown sclerites present. On tentacles are rather large sclerites, also yellowish, in double rows at middle. Supporting bundle composed of four or more spindles, large and pointed, one of which may be as long as 3 mm and extend well out of the polyp head. A few accessory yellowish sclerites are present on inner surface of polyp stalk. On cortex of branches and upper part of stem are large, heavy-looking, white or yellowish, straight or bent spindles reaching 5 mm long and 0.6 mm wide. On the basal cortex are also spindles for the most part, but these are shorter, at most 3 mm long and 0.3 mm wide, with low warts. A few may be forked at one end. Many are also much shorter and more slender. In the canal walls are also spindles, straight or bent, at most 2.3 mm long and 0.3 mm thick, with fine warts.

Reported from Viti Islands by Holm and later by Kükenthal and from Laccadive and Maldive Archipelago by Hickson. Philippine examples obtained from Puerto Galera Bay, Mindoro; one had a total height of 80 mm and a polypary expanse of 70 mm, and another slightly smaller, was 60 mm high and 65 mm wide. The colony as a whole is orange-yellow due to the color of the sclerites of the polyps and supporting bundle. Surface of the stem and branches light yellowish white.

DENDRONEPHTHYA ROEMERI Kükenthal. Plate 5, fig. 5.

D. roemeri KÜKENTHAL, Abhandlg. Senckenb. Naturforsch. Gesselschaft **33** (1911) 317.

Glomerate, with a tall columnar stem from which numerous, short, stumpy twigs of almost uniform length arise, giving the colony an almost uniform contour; polyps in small groups on short twigs arising from main stem, more compactly arranged at ends of larger branches and on top of main stem; polyp stalk short; anthocodial armature three to four in a row, with one outermost of each double row larger and extending out of polyp head; no crown sclerites present; formula:

$$\text{IV} = (1\text{ P} + 2\text{–}3\text{ p}) + 0\text{ Cr} + \text{strong S.B.}$$

Presumably a young colony with a total height of 75 mm and a polypary expanse of 33 mm. Stalk tall and columnar, giving rise to very many, short, unbranched, stumpy twigs more or less uniform in length, giving the colony a uniform contour. Base separated from rest of colony by collarlike, expanded, leaflike branches. Polyps in groups at ends of short twigs all over main stem but crowded together in large bunches at end of longer branches and main stem. Polyps about 0.7 mm long and about the same width, standing at an obtuse angle with slender stalk about 0.9 mm high. Anthocodial armature in eight double rows, three to four in a row. Of these the outermost of the lateral rows are very much larger, as long as 0.84 mm, and they extend well out of the polyp head. The other sclerites are smaller, about 0.42 mm long. No crown sclerites present. Supporting-bundle sclerites well developed, one of which may be as long as 3 mm, extending far out of the polyp head, giving the colony a decidedly spiny appearance. In cortex of upper stem and branches are numerous whitish spindles, 3 to 4 mm long, mostly arranged transversely. On basal cortex the spindles are shorter, at most 1.4 mm long and 0.25 mm wide. Majority of basal cortical sclerites are irregular, branched or star-shaped bodies with fewer

but larger warts. Cœnenchymal walls contain numerous, large spindles on the average 2 mm long, with wide, somewhat corrugated warts, in addition to few, very tiny, smooth, simple or irregular sticks.

Two full-grown colonies reported from Aru and Kei Islands. Philippine material obtained from Puerto Galera Bay is ochraceous orange in color.

DENDRONEPHTHYA ACULATEA Kükenthal. Plate 5, fig. 6.

D. aculatea KÜKENTHAL, Zool. Jahrb Syst. 21 (1905) 559, pl. 27, fig. 10.

Glomerate, colony flattened in one plane, basal sterile stalk very short, dividing into a number of stout branches and twigs dichotomously; polyps in groups of 8 to 15 on main branches and twigs; polyps in obtuse or right angle with a medium-sized polyp stalk; point sclerites three to four, with one outermost larger and extending out; crown sclerites absent; supporting bundle well developed; formula:

$$\mathrm{IV} = (1\,\mathrm{P} + 2\text{–}3\,\mathrm{p}) + 0\,\mathrm{Cr} + \text{strong S.B.}$$

From a very short sterile stalk about 20 mm high a number of main branches are given off that divide dichotomously to give rise to terminal and side twigs. Lower branches expanded and leaflike. Polyps in distinct and separate groups of eight to fifteen on the main branches and twigs. Polyp heads about 0.75 mm high and 0.8 mm wide at obtuse or right angle with a stalk about 1.2 mm long. Anthocodial armature in eight double rows, three to four in a row. Lower sclerites in the double rows are at most 0.45 mm long, while one of the two outermost is much larger, as long as 0.9 mm, and extends prominently beyond polyp head. No crown sclerites present, although two or more of the anthocodial sclerites may be in very obtuse angle with one another and may appear as crown sclerites. Supporting bundle strongly developed, composed of four or more strong spindles, one of which is very large, as long as 4 mm, and may extend for over 1 mm beyond polyp head. One or two of the smaller supporting-bundle sclerites may also extend beyond polyp head. On the ventral side of polyp stalk are closely arranged accessory sclerites about 0.6 to 0.7 mm long. On cortex of branches and twigs are large spindles up to 4.2 mm long and 0.3 mm wide, with numerous closely set warts. Underneath these are much smaller and thinner spindles. In basal cortex are smaller spindles

about 1 mm long and 0.14 mm wide with rounded but stronger warts. In addition there are numerous, small clubs, irregular and star-shaped bodies of various dimensions. In the cœnenchyma are flat spindles with numerous, low, rounded warts.

Previously reported from Nagasaki Bay. The Philippine example (C–122) is from Puerto Galera Bay, Mindoro. This has a total height of 95 mm and a polypary expanse of 90 mm. In alcohol the stem and branches are white, while the polyps are oranged-red or light yellow due to the color of the sclerites.

DENDRONEPHTHYA HICKSONI Kükenthal. Plate 5, fig. 7.

D. hicksoni KÜKENTHAL, Zool. Jahrb. Syst. 21 (1905) 556, pl. 27, fig. 8.

Glomerate, polyps in rounded masses which almost completely hide the main stem and main branches; polyp stalk short; supporting bundle well developed; point sclerites three to four, none extending out of the polyp head; no crown sclerites; formula:

$$IV = 1\ P + 2\text{–}3\ p + 0\ Cr + \text{strong S.B.}$$

A sterile stalk that extends for about one-third of the entire height of the colony arises from the base. The main stem divides into two main branches which in turn give off numerous secondary branches. These then divide to form terminal twigs where most of the polyps are located. Polyps are also found on twigs that arise directly from the stem and main branches. In any case, the polyps form more or less spherical groups that partly or completely hide the twigs and branches. Polyps about 0.98 mm long and 0.84 mm wide, making an obtuse angle with a short stalk about 0.7 mm long. Anthocodial armature consists of eight double rows, about three to four in a row. The outermost in a double row is slightly larger and thicker than the rest, about 0.75 mm long and 0.07 mm wide, but does not project beyond polyp head. The other point sclerites on the average are 0.65 mm long and 0.04 mm wide. All anthocodial sclerites are with rather large, prominent, widely separate warts. No crown sclerites present. Supporting bundle consists of three to five spindles, one or two of which may be as long as 4 mm and extend prominently beyond polyp head. On cortex of branches are numerous small or large spindles with numerous rounded warts. The largest are about 2.2 mm long and 0.2 mm wide. Toward the base these spindles become shorter and thicker and more heavily warted, at most 0.8 mm long and 0.2

mm wide. In addition, numerous irregular or star-shaped bodies are found on the cortex. In canal walls are straight or bent spindles up to 2 mm long and 0.35 mm wide with scattered low warts.

Previously reported from Tonga Island. The Philippine example (C–2335) was obtained from a floating buoy at Legaspi Bay, Albay. This has a total height of 150 mm and a polypary expanse of 80 mm. Color yellowish.

DENDRONEPHTHYA SEMPERI (Studer).

Spongodes semperi STUDER, Ann. & Mag. Nat. Hist. VI 1 (1888) 69.

Glomerate, colony tall, with columnar stalk and conical polypary; branches more or less unbranched; polyps small, rounded, at right angle with short polyp stalk; anthocodial armature in eight double rows, about three in a row; crown sclerites present; supporting bundle well developed; formula:

$$V = 3\ P + 2\text{–}3\ Cr + \text{strong S.B.}$$

Colony composed of a strong, rigid, columnar stalk that takes up about three-fourths of the entire height of colony and arises from several short stolons. Polypary more or less conical and starts basally, collarlike, above the limit of the stalk. At its edge several polyps are found all around. Above, the polypary is composed of numerous conical, pointed branches, round in cross section, each about 70 mm long and 5 mm in diameter at its base. Polyps arranged in small groups or bundles that are more or less uniformly scattered on the branches. Polyp heads rounded, about 1 mm high and about the same in width, standing at a right angle with short thick stalk. Anthocodial armature in eight double rows, usually three in a row. These are spindles about 0.3 mm long with deep, prominent, longitudinal stripes and few warts. Below the point sclerites are two or three rows of crown sclerites. Supporting bundle composed of numerous, strongly developed spindles about 1.2 mm long with large warts spreading towards the base but converging apically. One or two are longer, extending slightly beyond polyp head. Between the polyps, in the cortex of the branches, are bent spindles up to 1.8 mm long. On stalk cortex are slender spindles up to 4 mm long and 0.48 mm thick, provided with thickly and regularly set small slender warts. They are more numerous on the basal than on the upper part of the stalk. In the cœnenchymal walls are few, widely separate, somewhat smaller, smooth spindles.

Colony about 77 mm high, with a stalk 54 mm high and 23 mm in diameter. Polypary expanse 28 mm. Color whitish gray. Collected by Semper from the Philippines and first described by Studer. Exact locality unknown. Type in München.

II. DIVARICATÆ

DENDRONEPHTHYA GRIFFINI sp. nov. Plate 5, fig. 8.

Divaricate, flattened in one plane, polypary without any regular outline; few polyps located in small groups at ends of terminal twigs, polyps mostly found singly arising directly from surface of main branches and twigs; polyp stalk very short; anthocodial armature in eight double rows, about eight in a row, the outermost being larger and extending out of polyp head; no crown sclerites; formula:

$$\text{III} = (1\ \text{P} + 7\ \text{p}) + 0\ \text{Cr} + \text{strong S.B.}$$

A small decidedly flattened colony with a tall but stout and slightly flattened stalk. At about one-third of the entire height of the colony are two small leaflike branches, widely separated, not forming a complete crown around the stem. Above this the stem soon divides into three main branches, two lateral and one median, all flattened in one plane. At their ends they give off few terminal branches, mostly also in the direction of the flattened plane. Few polyps are in small groups at terminal twigs; majority single, arising directly from the stem and main branches. Polyps about 0.7 mm long and 0.6 mm wide, standing at an obtuse angle with a short stalk about 0.5 mm long. Anthocodial armature in eight double rows, about eight in a row, the outermost larger, extending out of the polyp head. One or two intermediate sclerites are visible between the double rows towards the outer end of the polyp head. The outermost sclerites, on the average, are 0.6 mm long, while the other anthocodial sclerites are about 0.3 mm long. All are deep reddish yellow with fine prominent warts. No definite crown sclerites present. Supporting bundle well developed, composed of three or more stout, strong, reddish spindles, one of which extends way beyond polyp head. On ventral side of polyp stalk are other accessory sclerites, spindles, also reddish yellow. In cortex of stalk and main branches are densely packed spindles of various dimensions, mostly lying tranversely. The largest are about 2.3 mm long and 0.21 mm wide with numerous small conical warts. The smallest are very slender spindles about 0.4 mm long and

0.03 mm wide, also with fine conical warts. At base are similar spindles, although here many of them are forked. A few basal cortical sclerites are much smaller and branched, with larger warts. All cortical sclerites are reddish with a slight tinge of yellow. No cœnenchymal sclerites found.

Type: No. C–197, University of the Philippine zoölogical collection; Puerto Galera Bay, Mindoro, 1912; collected by tangle in about 20 meters of water; L. E. Griffin collector. Total height 50 mm, with a polypary expanse of 35 mm. Whole colony reddish with a slight tinge of yellow. Tips of polyp heads whitish yellow due to color of tentacles.

This is more or less similar to *D. flammea* Sherriffs in branching and habitus, and it certainly belongs to the *cervicornis* group of Kükenthal. Here, however, numerous single polyps are found arising directly from the stalk and branches. The anthocodial armature approaches that of *D. microspiculata* in arrangement, although the sclerites here are larger and the habitus of the colony is very different.

DENDRONEPHTHYA MICROSPICULATA (Pütter). Plate 5, fig. 9.

Spongodes microspiculata PÜTTER, Zool. Jahrb. Syst. 13 (1900) 459, pl. 29, fig. 9; pl. 30, fig. 14.

Divaricate, with a slender stalk and with a firm, rounded or oval polypary with lower foliaceous branches; polyps in divergent groups, four to nine in a group, situated mostly on terminal twigs; polyps in obtuse to right angle with long polyp stalk; anthocodial sclerites in eight double rows, six to eight in a row, the outer larger and extending beyond polyp head; crown sclerites absent; supporting bundle well developed; formula:

$$\mathrm{II} = (1\ \mathrm{P} + 5\text{–}7\ \mathrm{p}) + 0\ \mathrm{Cr} + \text{strong S.B.}$$

Colony treelike, more or less rigid, with a long or short, but always slender, sterile stalk and a rounded or oval polypary. Lower branches directed ventrally and definitely foliaceous. Upper branches cylindrical and divided into a number of smaller side branches and terminal twigs on which the polyps are situated. Polyps in diverging groups of four to nine. Polyps on the average about 0.5 mm long and 0.6 mm wide, making an obtuse or right angle with a slender stalk about 1 mm long. Anthocodial armature in eight double rows of six to eight sclerites in a row. The outermost are large, about 0.5 mm long, and with a more heavily warted outer end that protrudes beyond

polyp head. The other sclerites are smaller, about 0.2 mm, weakly warted and they come closely together in acute angles. No crown sclerites present. Supporting bundle well developed, composed of several spindles about 2.5 mm long and thickly but finely warted, one or two of which extend for about 0.5 mm beyond polyp head. On cortex of upper stem and branches are bent spindles of various sizes, 0.1 to 4 mm long, with regular, slender, rounded, small warts. On basal cortex these spindles are shorter and thicker and provided with stronger, oftentimes branched, warts. They are on the average 1 mm long and 0.17 mm wide. In addition, there are present on basal cortex numerous smaller clublike or star-shaped sclerites. In cœnenchymal walls are strong spindles about 1.6 mm long and 0.32 mm thick, as well as three-rayed sclerites. In addition there are other smaller, irregular, thorny, flat sticks and stars about 0.1 mm long.

Philippine material consists of three small colonies, each with a total height of 35 mm and a polypary expanse of 35 mm, obtained from Puerto Galera Bay in water about 10 fathoms deep. They all agree in having reddish white stalk, deep red upper branches and supporting bundle sclerites, and white anthocodial spindles. This form has also been reported from Amboina.

DENDRONEPHTHYA DIVARICATA (Gray).

Spongodes divaricata GRAY, Proc. Zool. Soc. London (1862) 29.

Divaricate, polypary with a regular rounded boundary, the branches being not of uniform length, and not laterally flattened, but more or less rounded; polyps at obtuse to right angle with a long stalk; anthocodial sclerites in eight double rows, five in a row; crown sclerites absent; supporting bundle of the ensheathing type; formula:

$$IV = (1\ P + 4\ p) + 0\ Cr + \text{medium S.B.}$$

Colony with a tall, columnar stalk that arises from numerous thin stolons. Stalk gives off all around a number of branches the lower ones of which are foliaceous. The upper branches are slender and cylindrical, making almost a right angle with the stem, and giving off at their upper portions a number of diverging side branches on which the polyps are located. Polyps in diverging groups, about three to six in a group. Polyp heads about 0.5 mm long and 0.45 mm wide, making an obtuse to right

angle with a slender polyp stalk about 2 mm high. Anthocodial sclerites in eight double rows, about five in a row. The outermost sclerites are larger, about 0.32 mm long, and extend beyond polyp head. The others are smaller, about 0.18 mm long. All are thick, sparsely warted spindles. Supporting bundle medium in size with one, sometimes two, spindles, as large as 2.4 mm long and 0.1 mm thick, extending about 0.6 mm beyond polyp head. Supporting bundle spindles that are provided with weak but regularly arranged warts form a sheath around the base of polyp stalk. In cortex of branches and upper stem are spindles as long as 2 mm. Usually they are much smaller and have fine, irregularly arranged warts. In basal cortex are similar spindles, although here they are thicker and provided with densely arranged, large, stout, rounded warts. In addition, numerous small three- or four-rayed sclerites, on the average 0.2 mm long, also with stout rounded warts, are found in the basal cortex. In canal walls are stout spindles, 0.8 mm long and 0.14 mm wide, as well as clubs, and four- and three-rayed bodies. All these sclerites are provided with stout but low and rounded warts.

Color yellowish white. One example, in the München Museum, collected by Semper in the Philippines, has a total height of 40 mm and a stalk about 20 mm in height. The exact Philippine locality is not recorded.

DENDRONEPHTHYA RADIATA Kükenthal. Plate 5, fig. 10.

D. radiata KÜKENTHAL, Zool. Jahrb. Syst. 21 (1905) 584, pl. 28, fig. 18.

Divaricate, polypary without any regular contour and not flattened; polyps in small groups at ends of twigs and surface of main branches; polyp stalk short; anthocodial armature two to three in a row, one of the outermost much larger and extends out of the polyp head; below are one to two rows of crown sclerites; formula:

$$V = (1\ P + 2\ p) + 1\text{–}2\ Cr + \text{strong S.B.}$$

Colony with a short basal stalk separated from the rest of colony by expanded leaflike lower branches. Above this, the stem gives off several main cylindrical branches that in turn give off few short terminal twigs. Polyps in groups of five to twelve at ends of twigs and on surface of main branches. Polyps about 0.64 mm long and about the same in width, standing at an obtuse angle with a short stalk about 0.6 mm long.

Anthocodial armature in eight double rows, about two to three in a row on the lateral sides and only one pair on the ventral side. One of the outermost sclerites in a double row, especially that of the lateral sides, is much larger than the rest and extends out of the polyp head. This is about 0.5 to 0.6 mm long, slightly thicker and more warty on the outer end. The other point sclerites are smaller, at most 0.4 mm long, and slightly narrower. Below the anthocodial sclerites are one to two irregular rows of crown sclerites. Supporting bundle exceptionally well developed, composed of several sclerites, one or two of which are ivory white, very large, as long as 4 mm, and extend far out of the polyp head. On main branches and twigs are elongate, white spindles, as long as 3 mm, irregularly arranged and not crowded. On basal cortex are also slender spindles of various sizes with many minute conical warts. The longest are about 2.5 mm long mixed with many other smaller spindles and irregular radiate bodies with numerous warts. In the canal walls are few spindles as long as 1.3 mm, with scattered low warts.

Reported from Tonga Island by Kükenthal. Philippine specimens from Puerto Galera Bay have a total height of 50 mm and a polypary expanse of 50 mm. Polyps scarlet in life, stem whitish. Found in shallow water.

DENDRONEPHTHYA PÜTTERI Kükenthal. Plate 5, fig. 11.

Spongodes studeri MAY, Jena. Zeitschr. f. Naturw. 33 (1899) 171, pl. 4, fig. 36.

Dendronephthya pütteri KÜKENTHAL, Zool. Jahrb. Syst. 21 (1905) 625, pl. 29, fig. 30.

Divaricate, polypary with a more or less continuous contour but slightly flattened in one plane, twigs uniformly long, basal twigs expanded, leaflike; polyp stalk shorter than 2 mm, anthocodial armature one to two in a double row, one of which is long and extends far out of polyp head; crown sclerites well developed, under which are other converging sclerites; formula:

$$\text{VI} = 2\text{ P} + 2\text{–}3\text{ Cr} + \text{strong S.B.}$$

Colony long oval, slightly flattened in one plane. Sterile stalk rather short, separated from rest of colony by two broad, expanded, leaflike, lower branches that form an almost continuous ring around stem. Just above the ring, main stem gives off two side branches. It then continues upward and then divides into two main branches. Main stem as well as branches gives

off numerous short twigs on which the polyp groups are located. Polyps in divergent groups of five to twelve, giving an impression that the entire surface of colony is uniformly covered with polyps. Polyps about 0.5 to 0.7 mm long and 0.63 mm wide standing at an obtuse angle with a slender stalk about 1.5 mm high. Anthocodial armature consists of eight double rows of sclerites, one to two in a row, one of which is large and prominent, extending far out of the polyp head. Below anthocodial sclerites are two to three rows of crown sclerites arranged more or less transversely. Below these are still other converging sclerites without any definite arrangement. Long point sclerites about 0.47 mm long, while most of the crown sclerites are about 0.28 mm long. All polyp sclerites are wine red, and have fine warts. Supporting bundle composed of several long, warty spindles, one of which is extremely long, extending beyond polyp head. On ventral surface of polyp stalk are also numerous medium-sized spindles which, like the supporting bundle, are wine red. On cortex of twigs, branches, and upper stem there are numerous, closely crowded, white, slender spindles with fine warts. At basal cortex are spindles at most 0.9 mm long and 0.17 mm wide with regular fine warts. In stalk cœnenchyma are numerous, weak, smooth-looking, flat spindles, triradiates, or four-rayed bodies of small dimensions, none of which exceeds 0.5 mm in length. The majority are much smaller, about 0.15 mm long.

Base whitish brown or dirty gray, stem and terminal twigs white, polyps wine red. Philippine material (C–2007) was obtained from Legaspi Bay at a depth of 90 meters. One has a total height of 55 mm and a polypary expanse of 30 mm. The other is slightly smaller.

DENDRONEPHTHYA CERVICORNIS (Wright and Studer). Plate 2, fig. 3; Plate 5, fig. 12.

See Kükenthal, Jahrb. Syst. 21 (1905) 592, for complete synonymy; also, Sherriff, Proc. Zool. Soc. London (1922) 54.

Divaricate, polypary has no uniform contour, distinctly flattened in one plane; undermost branches expanded, leaflike; polyp stalk rather long, anthocodial armature only one or two pairs to a point, below which are crown sclerites in four to five rows irregularly arranged, supporting bundle strong; formula:

$$\text{VI} = 1\text{–}2\ \text{P} + 4\text{–}5\ \text{Cr} + \text{strong S.B.}$$

From a short base a rather tall, tapering stalk arises. Sterile base about one-fourth of entire height of colony separated from

polypary by two or more leaflike, expanded, ventrally directed branches forming a collar around stem. Above this, main stem gives off at different levels, mostly in one plane, branches of different lengths, making the polypary distinctly flattened. Branches give off terminal twigs at different levels. Polyps at ends of twigs in small groups, rather divergent. These have bodies about 0.7 mm high and 0.8 mm wide standing in obtuse angle with a long, slender stalk about 1 mm high. Anthocodial armature usually one pair, although at times another pair of very small sclerites are present at every point. The largest anthocodial sclerite of each point about 0.58 mm long and extends prominently beyond polyp head. Below point sclerites are four to five rows of crown sclerites 0.2 to 0.37 mm long, which may converge toward each other at a very obtuse angle or may lie almost horizontally. Supporting bundle composed of well-developed spindles one of which may be as long as 4 mm, extending prominently beyond polyp head. On inner surface of stalk are other spindles. All sclerites of polyp supporting bundle and polyp stalk reddish yellow.

In cortex of twigs and branches are long, slender, white spindles, not very densely crowded. The largest of these are about 4 mm long and 0.3 mm wide. In the cortex of the base are densely packed, stout spindles of various sizes, the largest of which are 2.2 mm long with numerous, low, corrugated warts, mixed with numerous smaller ones with less-prominent warts. Both kinds of sclerites may be forked or otherwise deformed. In the cœnenchyma similar but fewer sclerites are present.

Previously reported from Tahiti, Funafuti, Kei, New Britain, and Andaman Islands. One Philippine example (C–2004), from Taytay Bay, with a total height of 110 mm and a polypary expanse of 40 mm, has stalk, twigs, and branches white, and the polyp stalk and polyp heads reddish yellow. Another example (C–2314) is smaller, with a total height of 60 mm and a polypary expanse of 60 mm. Instead of having one main tapering stalk, three main branches arise just above the lower leaflike branches. The coloration is the same.

DENDRONEPHTHYA GRACILLAMA Kükenthal. Plate 5, fig. 13.

D. gracillama KÜKENTHAL, Zool. Jahrb. Syst. 21 (1905).

Divaricate, polypary flattened laterally, with an oval outline, lower branches leaflike, polyps in small divergent groups at ends of twigs, polyp stalk short, anthocodial armature in eight double

rows, with one pair of point sclerites, crown sclerites three to four, slightly converging toward anthocodial points; formula:

$$\text{VI} = 1 \text{ P} + 3\text{–}4 \text{ Cr} + \text{strong S.B.}$$

Colony with tall, columnar stalk more than one-half of entire polypary. Stalk separated from rest of polypary by two separate, basal, leaflike branches. Stalk divides above to form three main branches that in turn give rise to numerous small side branches. Polyps located in divergent groups at ends of twigs, in groups of four to ten. Entire polypary distinctly flattened with an oval outline. Polyps about 0.7 to 0.8 mm long and 0.9 mm wide at an obtuse angle, almost right, with a short stalk about 0.9 mm long. Anthocodial armature composed of eight double rows, usually only one pair in a double row, one of which is about 0.8 mm long and extends prominently beyond polyp head. Between the double rows are also a pair of very small sclerites lying in the direction of polyp head axis. Crown sclerites well developed, about three to four horizontal or slightly converging rows under each anthocodial point. Each crown sclerite about 0.3 mm long. Supporting bundle also well developed, consisting of two or more small and one or two very large ones, the largest being as long as 3 mm and extending more than 1 mm beyond polyp head. On ventral side of polyp stalk are accessory orange-yellow spindles, more or less arranged in chevrons. In cortex of upper stem and branches are numerous spindles up to 1.8 mm long and 0.16 mm wide. At lower portions of stalk are small star-shaped bodies about 0.13 mm long, and small spindles about 0.5 mm long. Canal walls contain weak sticks about 0.1 mm long which at lower portions of the stem become mixed with small star-shaped bodies.

Philippine material was obtained attached to a cable in Legaspi Bay in about 90 meters of water. The total height is 70 mm and the polypary expanse is 45 mm. Color of stalk whitish, polyps orange-yellow.

This form was first called *D. flabelligera* Studer by Holm, but later renamed *D. gracillama* by Kükenthal as he found several differences between the present form and *D. flabelligera* of Studer.

DENDRONEPHTHYA FLAMMEA Sherriffs. Plate 5, fig. 14.

D. flammea SHERRIFFS, Proc. Zool. Soc. London (1922) 57.

Divaricate, polypary decidedly flattened with irregular outline, lower branches leaflike, not forming a complete collar around

stem; most branches given off in one plane; twigs short and not numerous; polyps in groups of five to seven, although a few may be found singly on branches; anthocodial armature one to two in a row, the two outer extending far out of the polyp head; crown sclerites in three horizontal rows; formula:

$$\text{VI} = 1\ \text{P} + 3\ \text{Cr} + \text{strong S.B.}$$

Sterile stalk short and laterally flattened. This gives off two main branches with two, small, leaflike, expanded branches just at the point where the larger branches are given off. Lower expanded branches do not form complete collars around stem. Main branches give off several short, rather stout, secondary branches at different levels, mostly in one plane, making the colony more or less distinctly flattened. Terminal twigs that are also short and stumpy give rise to the polyp groups. A few polyps may be found singly on branches. Polyps in well scattered groups of five to seven, making the branches and twigs distinctly visible. Polyp heads relatively small, about 0.7 mm wide and 0.5 mm long, standing in obtuse angle with a short, stout polyp stalk, at most 0.8 mm long. Anthocodial armature consists of eight double rows of one to two in a row. Outermost sclerites much larger, one of which is as long as 0.6 mm, extending far out of polyp head. Two intermediate sclerites between two points are much smaller. Below anthocodial armature are crown sclerites arranged more or less in three horizontal rows, each sclerite being 0.3 mm long. All anthocodial and crown sclerites are white spindles with fine warts. Supporting bundle composed of three or more slender spindles, one of which extends for about 0.5 mm beyond polyp head. On ventral side of polyp stalk are numerous spindles of various sizes. Supporting bundle and stalk sclerites pink and with fine warts. In twigs and branches are red spindles of various dimensions, the largest of which is about 2.5 mm long and 0.3 mm wide. These tend to stand out from the general cortex. All sclerites mentioned by Sherriffs (1922) in his type are present in the cortex of this example. Unlike the type, however, few rather large simple spindles, triradiates, and forked spindles with prominent warts were found in the canal walls. Philippine material (C–2320) from Albay Bay, Luzon, has a total height of 65 mm and a total polypary expanse of 40 mm. Stem, branches, twigs, polyp stalk, and supporting bundle pink; polyp heads white due to color of the spicules.

III. UMBELLATÆ

DENDRONEPHTHYA REPENS Kükenthal. Plate 5, fig. 15.

D. repens KÜKENTHAL, Zool. Jahrb. Syst. 21 (1905) 678, pl. 31, fig. 48.

Umbellate, the umbels not combining to form hemispherical masses; branches of approximately the same length, thus forming a continuous surface; groups of polyps situated on ends of branches; polyp stalk slender, polyp body slender, with no crown sclerites; with many small point spicules, none extending out; formula:

$$I = \text{many p} + 0\ \text{Cr} + \text{strong S.B.}$$

Colony with very tall, columnar stalk that rises undivided for about half of the entire height of colony. Separating the sterile stalk from the polypary is a ring of expanded, ventrally directed, curved, lower branches that form an almost complete collar around the stalk. Beyond this the stem divides dichotomously, ending on small terminal twigs arranged in the form of umbels on which the polyps are located. Few umbels may also arise from main branches. Polypary may be rounded, oval, or irregular. Polyps in groups of twelve to twenty. Polyps when fully expanded are slender, about 0.7 to 0.77 mm long (excluding tentacles), and 0.56 mm wide, making a right or obtuse angle with a slender polyp stalk about 1 mm long or longer. Anthocodial sclerites are small, densely packed sticks in eight double rows, very numerous in a row, none of which extend out of the polyp. Largest polyp sclerites about 0.11 mm long, although many are much smaller. In tentacles are numerous tiny sclerites arranged in two transverse rows. All polyp sclerites white. On inner surface of polyp stalk are also numerous small sclerites, but these are purplish red. Supporting bundle composed of two, sometimes more, reddish sclerites which project beyond polyp head. Basal cortical sclerites are stout short spindles, on the average 0.4 mm long and 0.12 mm wide with low wide warts. These spindles are often forked or four-rayed. In addition there are very numerous, small, radiate or irregular bodies with low, wide or pointed warts or projections of various dimensions and shapes. In cœnenchyma of base and stalk are very large stout spindles of various dimensions with conical warts. Many of these are also forked and may be reddish.

Main stalk purplish red, main branches yellowish white, terminal twigs deep purplish red; polyps white. Color mostly due to color of sclerites.

Kükenthal's (1905) type was only a small portion of a colony from the Philippines, and his description of the habitus of the colony is not typical. In the Berlin Museum there are fifty-six examples of this species collected in various parts of the Philippines by S. F. Light, L. E. Griffin, and A. L. Day in 1915. The smallest colony is 35 mm high with a polypary expanse of 18 mm. The largest has a total height of about 100 mm and a polypary expanse of 60 mm. All of them show the coloration as described above.

DENDRONEPHTHYA MANYANENSIS sp. nov. Plate 5, fig. 16.

Umbellate, with a long, tall, sterile stalk and spreading polypary; polyps in form of umbels grouped together to form hemispherical clusters only at ends of terminal twigs; polyps elongate at obtuse angle with a medium length stalk; anthocodial armature in eight double rows, four to twelve small sclerites in a row; crown sclerites absent; supporting bundle poorly developed; formula:

$$II = 4\text{–}12\ p + 0\ Cr + \text{weak S.B.}$$

Sterile stalk tall, columnar, and slender, rising to a height of about 30 mm before branching. At its upper end the stalk gives off three main branches that at once divide to form the secondary branches. These then, by several branchings, finally end in terminal twigs where the polyps are located. Terminal twigs form umbellike groups and several umbels are grouped to form clusters, all umbels being formed only by the terminal twigs. Polyp heads are elongate and more or less tubular, about 0.9 mm long and 0.7 mm wide, making a very obtuse angle with a stalk about 0.8 mm high. In many cases it is rather hard to see the exact line of division between the stalk and the head. Anthocodial armature in eight very distinct double rows of small spindles of almost uniform size, none extending out. On the four dorsal double rows there are ten to twelve in a row; on the two ventrolateral six to eight in a row, and on the two ventral double rows four to six in a row. Point sclerites on the average are 0.23 mm long with fine-pointed prominent warts. Crown sclerites absent. Supporting bundle poorly developed

and of the ensheathing type. This is composed of six or more spindles which adhere closely to the dorsal side of polyp stalk, none of them projecting beyond the polyp head. The largest supporting bundle sclerite is usually less than 1 mm long. On cortex of twigs, branches, and upper stalk are very slender spindles at most 0.56 mm long and 0.042 mm wide with a few conical prominent warts. In addition are tiny, warty sticks or irregular bodies of smaller dimensions. On basal cortex are only tiny, irregular star-shaped or branched bodies, on the average 0.14 mm in diameter, which are densely packed together. No spindles present. No sclerites could be seen in the cœnenchymal walls of stalk.

Type: No. C–140, University of the Philippines zoölogical collection, from Puerto Galera Bay, Mindoro, two specimens. One specimen has a total height of 50 mm and a polypary expanse of 40 mm. The other has a total height of 40 mm and a polypary expanse of 30 mm. In alcohol, stalk, branches, and twigs are fleshy, the polyps yellowish and the sclerites white.

This form belongs to the *collaris* group of Kükenthal and is closest to *D. umbellifera* in habitus. None of the other six species belonging to this group agrees with the present species in spiculation and anthocodial armature.

DENDRONEPHTHYA BREVIRAMA (Burchardt). Plate 5, fig. 18.

Spongodes brevirama BURCHARDT, Alcyonaceen von Thursday Island und von Amboina, Semon Forschungsreisen 5 (1898) 438–439.

Umbellate, umbels not forming spherical groups; branches seemingly of the same length, giving the colony a slight flattened, long-oval contour; umbels with a flat or slightly convex surface; polyp stalk short, about 1 mm or shorter; anthocodial armature six to eight in a row, the outermost not extending out; crown sclerites absent; formula:

$$\text{II} = 6\text{–}8\ \text{p} + 0\ \text{Cr} + \text{strong S.B.}$$

A very short base gives rise to a vertical, slightly flattened, flaccid stalk, which in turn gives rise to several short branches at different levels. Branches divide to form terminal twigs arranged umbellike. Lower branches weak and slightly leaflike, not forming a complete collar around stem. Polyps in seemingly crowded groups of five to twenty on surface of colony, at ends of umbels. Polyps about 0.7 mm long and 0.63 mm wide, making an obtuse, or nearly right, angle with a stalk about 1 mm long or shorter. Anthocodial armature consists of eight close double

rows of white spindles, about six to eight in a row, the outermost not much larger than the rest and extending only a very short distance out of the polyp head, or not at all. Anthocodial sclerites on the average about 0.3 mm long, although one or two of the outermost may be as long as 0.42 mm. In tentacles are double rows of tiny reddish sclerites. Supporting bundle composed of four or more slender red spindles, one of which may be as long as 2.5 mm and extends out of polyp head. On ventral side of polyp stalk are few accessory spindles, at most 0.2 mm long. At ends of twigs are numerous spindles of various sizes, mostly arranged along their long axes. On stem and main branches are slender spindles, at most 2 mm long and 0.15 mm wide, with prominent warts. In basal cortex are stouter spindles about 0.5 mm long in addition to numerous three-rayed or four-rayed sclerites with prominent warts.

A Philippine example (C–156) was collected by Light by means of dredging in the northwest channel leading to Puerto Galera Bay, Mindoro, in 13 to 25 meters of water with sandy bottom. The specimen has a total height of 56 mm and a polypary expanse of 40 mm. Stalk and main branches whitish; terminal twigs red, and polyps white.

DENDRONEPHTHYA FLORIDA (Esper). Plate 2, fig. 2; Plate 5, fig. 17.

See Kükenthal, Zool. Jahrb. Syst. 21 (1905) 651, for complete synonymy.

Umbellate, umbels do not form definite hemispherical groups; branches nearly of the same length, giving the polypary a uniform contour that may be slightly flattened in one plane or not; umbels with convex outer surface; polyp stalk rather long; polyp armature in double rows, five to seven in a row, none extending out of polyp head; no crown sclerites; formula:

$$\text{III} = 5\text{–}7 \text{ p} + 0 \text{ Cr} + \text{strong S.B.}$$

Stalk columnar, high, about half of the entire height of colony. This is separated from rest of colony by five leaflike expanded branches that closely form a collar around the stem. Above this the main stem gives off several, small, short twigs and then divide into two or more main branches. These in turn subdivide several times and finally give rise to the terminal umbellike twigs on which the polyp groups are located. The branches may or may not all arise in one plane. Polyps mostly in groups on surface of colony. Polyps about 0.42 mm long and 0.49 mm wide, making a very obtuse angle with a stalk usually about 1 mm

long. In certain cases the polyps may stand almost upright so that no sharp boundary between stalk and polyp head can be seen. Polyp armature in eight double rows, five to seven in a row, wine red, usually about 0.15 mm long, although a few may be as much as 0.3 mm long. None of the uppermost sclerites extends beyond polyp head. Tentacles with numerous rounded pinnules with very few or no sclerites. No crown sclerites are visible, inner surface of polyp stalk and basal portions of polyp bodies free from sclerites. Supporting bundle composed of three or more large reddish spindles, one or two of which extend beyond polyp head. On basal cortex are stout spindles with pointed ends. They are 0.8 mm long and 0.154 mm wide with low, simple, or slightly branched warts. Many of cortical sclerites are also three-rayed, four-rayed, or otherwise irregular. In addition there are very numerous, small, irregular bodies with blunt or pointed projections of various shapes and dimensions. In cœnenchyma are very large, stout, simple or forked spindles with low, rounded or slightly divided, warts.

Base of main stem purplish red, upper portion of stem, branches, and twigs of umbels whitish; polyps yellowish white, but anthocodial armature and supporting bundle reddish purple.

Philippine material (C–11 and 112) includes three colonies of unknown locality. The largest has a total height of 90 mm and a polypary expanse of about 60 mm. The coloration of the three colonies agrees very closely with Esper's original illustration of the species, although it differs slightly from those described by Gray (1862) and Kükenthal (1905).

DENDRONEPHTHYA ANGUINA (Wright and Studer).

Spongodes anguina WRIGHT and STUDER, Challenger Report 31 (1889) 205–207.

Umbellate, colony with a tall columnar stalk, all branches of the same length, polypary rounded, umbels forming small rounded groups, polyps small, at right angle with a strong stalk, anthocodial armature in eight double rows, about six in a row, outermost slightly larger and extending a little beyond polyp head; crown sclerites absent; supporting bundle well developed; formula:

$$\text{III} = (1\ \text{P} + 5\text{–}6\ \text{p}) + 0\ \text{Cr} + \text{strong S.B.}$$

Colony with a long, cylindrical, soft stalk that extends for about eight-ninths of the entire height of colony. Polypary composed

of a number of lower, strong, horizontal branches arising at the same level. Above these is another set of branches, directed more upwards, forming a whorl around the tip of stem. Branches all of the same length, giving the polypary a rounded contour. At their ends are the twigs, which give rise to the umbels composed of five to ten polyps. Umbels come together in more or less rounded groups. Polyps are more or less flat, standing at a right angle with their strong stalk. Anthocodial armature in eight double rows of about six fine sclerites in a row, the outermost larger and slightly projecting beyond polyp head. These sclerites are as much as 0.5 mm in length. Tentacles with two rows of converging sclerites up to 0.12 mm long. Supporting bundle composed of numerous spindles up to 1 mm long, a few of which extend slightly beyond polyp head. In cortex of branchlets are few longitudinal slender spindles up to 1.5 mm long with fine warts. The larger branches as well as the stalk have a soft outer surface provided with few irregular bodies. In them as well as in the canal walls, widely separate, star-shaped bodies about 0.12 mm long are also found.

General color whitish yellow, polyps red, tentacles whitish yellow. The largest specimen collected by the Challenger Expedition is 180 mm high with a stalk 150 mm long and 10 mm wide, and a polypary expanse of 43 mm. The species is not represented in the present collection.

DENDRONEPHTHYA MALAYA sp. nov. Plate 5, fig. 19.

Divaricate, flattened, with an oval periphery; all secondary branches almost of the same length; lower branches foliaceous; polyps small, in diverging groups at ends of twigs and at right angle with slender stalk; point sclerites small, four to five in a row with the outermost only slightly larger and at times extending beyond polyp head; crown sclerites absent; supporting bundle well developed; formula:

$$IV = 4\text{–}5\ p + 0\ Cr + \text{strong S.B.}$$

Colony treelike, with a cylindrical, columnar, sterile stalk and flattened polypary with an oval periphery. Stalk arises from numerous rootlike stolons and grows vertically for some distance before branching. Lower branches foliaceous and ventrally directed. Above these, stem divides into three main branches. These, in turn, give off numerous side branches and finally to the terminal twigs. Polyps in groups of four to ten, the polyps

in a group distinctly diverging from each other. Polyps delicate-looking, about 0.77 mm long and 0.65 mm wide, making almost a right angle with a slender stalk 1 to 1.4 mm long. Anthocodial sclerites in eight double rows of acutely converging sclerites, four to five in a row. These sclerites are usually 0.3 to 0.4 mm long and 0.02 mm wide, with fine warts. Outermost may be slightly longer and may project slightly beyond polyp head. Crown sclerites absent, although in distorted polyps the lower point sclerites may be abnormally placed so as to appear like crown sclerites. Supporting bundle consists of about six very long slender spindles, one or two of which may be as long as 3 mm, extending beyond polyp head for about 1 mm. On cortex of upper stem and branches are simple spindles, at most 2.4 mm long and 0.14 mm wide, with fine low warts. On basal cortex are spindles, at most 1 mm long and 0.12 mm wide, with prominent, large, truncate warts, mixed with spinous clubs and irregularly branched bodies, on the average 0.35 mm long and 0.14 mm wide, also with prominent warts. In cœnenchymal walls are few spindles, about 1.3 mm long and 0.15 mm wide, with few but prominent warts.

The type (C–139), from Puerto Galera Bay, Mindoro, has a total height of 60 mm and a polypary expanse of 45 mm. Stem and branches white, polyps light fleshy yellow, all sclerites white.

This form is nearest *D. depressa* in anthocodial armature. It belongs to the *rigida* group of Kükenthal, in the Divaricatæ, but differs in many respects from the nine species listed under this group.

DENDRONEPHTHYA RUBRA (May). Plate 5, fig. 20.

Spongodes rubra MAY, Jena. Zeitschr. f. Naturw. **33** (1899) 169, pl. 4, fig. 32.

Colony with a short stalk and a horizontally flattened polypary, branches dividing dichotomously, all polyps in groups only at periphery; polyps at a right or acute angle with a medium long stalk, anthocodial sclerites in eight double rows, usually four to five in a row, one of the outermost larger and extending beyond polyp head; two pairs of small sclerites between the outer portions of the double rows; no crown sclerites present; supporting bundle strongly developed; formula:

$$\text{IV} = (1\ \text{P} + 3\text{–}4\ \text{p}) + 0\ \text{Cr} + \text{strong S.B.}$$

Colony with a short stalk that gives off a number of horizontal main branches in such a way that the polypary appears horizon-

tally flat. These main branches are cylindrical and divide dichotomously to form the side branches and finally the terminal branchlets where the polyp groups are exclusively located. Polyps in groups of five to ten, the groups not coming together but more or less scattered uniformly on the outer surface of the polypary. Polyps more or less rounded, on the average 0.65 mm high and 0.75 mm wide, making a right or acute angle with a stalk about 1 mm high. In small polyps anthocodial armature consists of eight double rows, mostly weakly warted wide spindles five to eight in a row. Usually the sclerites are about 0.25 mm long and 0.045 mm wide. In large mature polyps there are only four to five in a row; one of the two outermost in a row is much larger, being about 0.5 mm long and extending out prominently. Between the double rows, towards the tentacles, are one or two pairs of much smaller sclerites. Crown sclerites absent. Supporting bundle well developed, one of the spindles attaining a length of 3.5 mm and extending out of the polyp head for over 1 mm. Supporting-bundle spindles with very fine warts. On the cortex of upper branchlets, slightly bent large spindles up to 4 mm long with larger warts are found mixed with numerous smaller ones. In the cortex of the main stem similar, although slightly thicker, spindles provided with regularly set, long, slender warts with rounded tips are present. Endodermal canal walls provided with large and small, almost smooth, greatly bent spindles up to 1.8 mm long.

Colony dark red, polyps white.

The example originally described by May was obtained from the Philippines, but the exact locality is not known. It has a total height of 40 mm, a stalk about 17 mm high, and a polypary expanse of 43 mm.

DENDRONEPHTHYA UMBELLATA (Wright and Studer).

Spongodes umbellata WRIGHT and STUDER, Challenger Report 31 (1889) 203, 204, pl. 36E, figs. 3*a*, 3*b*.

Umbellate, polypary flattened, mostly developed on one side with a more or less circular or oval outline; polyps mostly at terminal twigs in form of small umbels; polyps at obtuse angle with a short stalk; anthocodial armature in eight double rows, three to four in a row, one of the outermost extending prominently; no crown sclerites present; supporting bundle of medium size; formula:

$$\text{IV} = 1\,\text{P} + 2\text{–}3\,\text{p} + 0\,\text{Cr} + \text{medium S.B.}$$

Colony flaccid, treelike, and mostly developed only in one plane. Stalk short and provided with prominent longitudinal folds. Polypary more or less circular in general outline. On one side there are hardly any polyps present, while on the other the polyps are arranged in small umbels. The branching is characteristic in that the main and side branches are fully free from polyps and thus fully visible. The side branches at their ends give rise to several short terminal branchlets, all of the same length, from which the polyps stand out almost all of the same height. Lower branches closely crowded, shorter, somewhat flattened foliaceous, and surrounding the stem like a collar. Polyps cuplike, about 0.55 mm high and just as broad, standing at a very obtuse angle with a stalk about 1 mm long. Anthocodial armature in eight double rows, three to four in a row, one of the outermost in each double row much larger, about 0.52 mm long, strongly warted, and extending out of the polyp head. The other sclerites are smaller, about 0.25 mm long, and weakly warted. No crown sclerites. Supporting bundle of medium size, composed of several straight, weakly warted spindles about 2 mm long, one of which usually extends a little beyond polyp head. In the cortex of upper branches are slender, finely warted, slightly bent spindles about 2 mm long. Basal cortex in addition to few spindles, clubs, and three-rayed sclerites about 0.6 mm long, has numerous small star-shaped bodies about 0.13 mm in diameter. In the canal walls are similar, but smaller, flatter and smoother, star-shaped sclerites.

Colony white, polyps and sclerites of terminal branchlets dark red. Philippine material upon which the original description of Wright and Studer was based is an incomplete specimen collected by the Challenger Expedition from water 8 to 11 fathoms deep, at Zamboanga, Mindanao. *Spongodes bicolor*, described by Wright and Studer and by Burchardt (1898), is evidently this species.

Genus STEREONEPHTHYA Kükenthal

Stereonephthya KÜKENTHAL, Zool. Jahrb. Syst. 21 (1905) 694.
Stereonephthya THOMSON and MACKINNON, Trans. Linn. Soc. London 13 (1909) 185.

The genus *Stereonephthya* is a later name for Gray's (1869) subgenus *Spoggodia*. Gray's diagnosis of this is as follows: "The polyps isolated in the prominent isolated spiculose subcylindrical cells, scattered on the sides, or forming tips of the

branchlets." Also Klunzinger (1877) recognized this subgenus by stating that "Die Kopfchen einzeln, zerstreut, nicht in deutliche Läppchen gruppiert." Wright and Studer (1889) included this subgenus in their "divaricatæ" group under the genus *Spongodes*. Holm (1895) used *Spongodes* as the generic name and divided it into four subgenera; namely, *Spoggodia, Nephthya, Panope,* and *Spongodes*. According to him the subgenus *Spongodes* has the polyps distinctly arranged in bundles, while in the other three the polyps are not so arranged. Furthermore, *Spoggodia* has fingerlike cylindrical branches and differs from *Nephthya* and *Panope,* which have the branches divided into lobes. Kükenthal (1898) also has pointed out that *Spoggodia* is recognizable through its polyps which are scattered singly and not united in lobes, on long cylindrical branches. In a later work, Holm (1904) suggested that in as much as *Nephthea* was elevated to the rank of genus, *Spoggodia* should also be so treated. This was done by Kükenthal (1905), who at the same time changed the name *Spoggodia* to *Stereonephthya*. *Spoggodia* could not be retained as from the time of Dana (1864) it has been used synonymously with *Spongodes*. The name *Spongodes* also could not be used, as its type, *S. celosia,* is a species of *Nephthea*. Thus, when Kükenthal changed the name *Spongodes* to *Dendronephthya,* he also had to change the name *Spoggodia*. Contemporary workers assign the following diagnosis to *Stereonephthya:* Rigid Nephthyidæ whose polyps are provided with a supporting bundle and are neither in lobes nor in bundles but arranged singly or in small groups on a stem that may or may not give rise to main branches.

There are at least twenty-two species of *Stereonephthya* described. Only two of these are found in the Philippines. In this paper I describe one species that is evidently new.

STEREONEPHTHYA CRYSTALLINA Kükenthal.

S. crystallina KÜKENTHAL, Zool. Jahrb. 21 (1905) 703, pl. 32, fig. 56.

Colony very brittle, composed of a low membranous base from which a few, thick, rapidly tapering stems arise. Side branches most numerous around the lower portion of the stem. Polyps are arranged singly, far apart at lower parts of branches but closer together towards their ends. Polyp bodies about 0.7 mm long and 0.6 mm wide, making an acute to right angle with a stalk 1.3 mm high. Anthocodial sclerites in eight double rows,

five to seven spindles in a row. Those on the outer rows are spindles 0.2 to 0.3 mm long, while those on the inner rows are slightly smaller. Two or three rows of few crown sclerites are present. Supporting bundle with one or two slender elongate spindles up to 2 mm long, which may extend beyond polyp head for 0.5 mm. Small spindles are present on the ventral side of polyp stalk. On cortex of branches are weak, slightly bent, slender spindles up to 2 mm long with few strong warts. On the lower cortex are shorter but thicker spindles as long as 0.7 mm, with high elongate warts, as well as clubs and radiate bodies. Numerous spindles with few and low warts are present in cœnenchymal wall.

Colony light whitish yellow, branches on upper part with bright pink tinge. Total height of colony 37 mm, polypary expanse 35 mm.

This description is based on a Philippine specimen in the Vienna Museum of which the exact locality and collector are unknown.

STEREONEPHTHYA BELLISSIMA Thomson and Dean.

S. bellissima THOMSON and DEAN, Siboga-Expedition 13d (1931) 143, pl. 7, figs. 2, 3, 4, and 5.

From a very weak, thin-walled, very short, sterile base, an upright stem arises which gives off a number of side branches. The whole colony appears flaccid, not rigid, especially near the base, where there is a tendency to collapse. Polyps arise either singly or in small groups, but never in bundles. They are present all over the polypary, although they are most numerous at the end branches, where they are more closely arranged together. Polyps on the average are 1.3 mm long and 0.7 mm wide, making a very acute angle with a stalk, usually short, not more than 1 mm long. Anthocodial armature only in five double rows, the three inner double rows being absent. On the three outer double rows there are six to eight spindles in a row, while on the laterals there are only three to four in a row. The sclerites are elongate, slender spindles about 0.35 mm long with few prominent warts. No crown sclerites present. Supporting bundle is of the ensheathing type, usually two spindles of which are larger, about 2.4 mm long, protruding beyond polyp head for about 0.7 mm. On the cortex of branches and stalk are few slender spindles, at most 1.2 mm long and 0.084 mm wide, with few conical warts. Under these are numerous small, weak,

slender sticks about 0.12 mm long, densely packed together. In the cœnenchyma are very few pointed spindles, usually 0.42 mm long and 0.07 mm wide, with few weak warts.

In the collection there are four colonies which agree very closely with the description of *S. bellissima* of Thomson and Dean. In our specimens, however, spindles although very few are found in the cœnenchyma. The sclerites of stalk and branches are white, supporting bundle deep red, while the anthocodial sclerites are light pink. The largest colony has a total height of 90 mm and a polypary expanse of 60 mm.

Locality: Puerto Galera Bay, Mindoro.

STEREONEPHTHYA CAMPANULATA sp. nov.

Colony with a rather weak encrusting base from which two or more stems arise. These at once divide irregularly to form numerous branches from which short side branches arise. Polyps usually arise singly from the stem and main branches, but at the ends of side branches they are more numerous and more closely set, although they cannot be said to form bundles. A polyp is about 1.5 mm long and 0.85 mm wide, hanging like a bell at a very acute angle from a short stalk about 0.7 mm high. Anthocodial armature in only five double rows, the three inner being absent. On the outer double rows there are usually six sclerites in a row, while on the lateral there are three to five in a row. The outer sclerites are longer, about 0.65 mm long, with a swollen, glistening, white portion just behind the pointed tip which protrudes slightly beyond polyp head. The outer sclerites are also spindles, slightly shorter, about 0.55 mm long. All anthocodial sclerites are pointed and provided with numerous conical warts. On tentacles are numerous fine sclerites. Supporting bundle is of the ensheathing type, composed of eight to ten reddish spindles, usually about 1 to 1.8 mm long, two of which tend to extend out of the polyp head only for a short distance. On the cortex branches are three kinds of sclerites as follows: (*a*) A few, large, stout, reddish sclerites about 2 mm long and 0.14 mm wide; (*b*) numerous, densely packed, smaller spindles; and (*c*) many, tiny, elongate sticks, all with rounded warts. On the basal cortex are stouter spindles, usually about 0.9 mm long and 0.14 mm wide, with rounded warts, and small clubs or branched sclerites or irregular bodies of various dimensions. Canal wall very thin with very few widely scattered spindles at most 0.56 mm long and 0.05 mm wide.

Colony purplish red due to color of cortical sclerites and supporting bundles. Polyps whitish.

Type: No. C–2534, University of the Philippines zoölogical collection, from Puerto Galera Bay, Mindoro. The largest of the three colonies has a total height of 85 mm and a polypary expanse of 80 mm.

This differs from *S. bellissima*, to which it is closest, in having (*a*) larger anthocodial sclerites, the outermost of which are very prominent and extend beyond polyp head; (*b*) shorter and narrower branches and not very closely crowded, but larger polyps; and (*c*) another type of stalk and branch armature.

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ILLUSTRATIONS

PLATE 1

Sclerites from the stalk cortex and cœnenchyma of various species of *Sarcophyton;* × 100.

FIG. 1. *Sarcophyton latum* (Dana).
2. *Sarcophyton tersum* sp. nov.
3. *Sarcophyton ehrenbergi* Marenzeller.
4. *Sarcophyton crassocaule* J. Moser.
5. *Sarcophyton puerto-galerae* Roxas.
6. *Sarcophyton moseri* Roxas.
7. *Sarcophyton trocheliophorum* (Marenzeller).
8. *Sarcophyton digitatum* J. Moser.
9. *Sarcophyton elegans* J. Moser.
10. *Sarcophyton glaucum* (Quoy and Gaimard).

PLATE 2

FIG. 1. *Paralemnalia thyrsoides* (Ehrenberg); portion of a colony, × 1.
2. *Dendronephthya florida* (Esper); portion of a colony to show an umbellate form, × 0.5.
3. *Dendronephthya cervicornis* (Wright and Studer); a portion of a colony to show a divaricate form, × 0.5.
4. *Dendronephthya guggenheimi* sp. nov.; a portion of a colony to show a glomerate form, × 0.5.
5. *Stereonephthya bellisima* Thomson and Dean; terminal portion of a colony, × 2.
6. *Sinularia mayi* Lüttschwager; cortical sclerites, × 200.
7. *Sinularia polydactyla* (Ehrenberg); cortical sclerites, × 200.
8. *Sinularia leptoclados* (Ehrenberg); cortical sclerites, × 200.
9. *Sinularia macrodactyla* Kolonko; cortical sclerites, × 200.
10. *Sinularia flexibilis* (Quoy and Gaimard); cortical sclerites, × 200.

PLATE 3

Sclerites from stalk cortex and cœnenchyma of *Capnella* and *Litophyton; a,* from stalk cortex; *b,* from stalk cœnenchyma; *c,* from polyp body; *d,* from tentacles.

FIG. 1. *Capnella imbricata* (Quoy and Gaimard), × 100.
2. *Capnella sabangensis* sp. nov., × 100.
3. *Capnella ramosa* Light, × 100.
4. *Capnella parva* Light, × 100.
5. *Litophyton orientale* sp. nov., × 100; except *b,* which is × 50.

PLATE 4

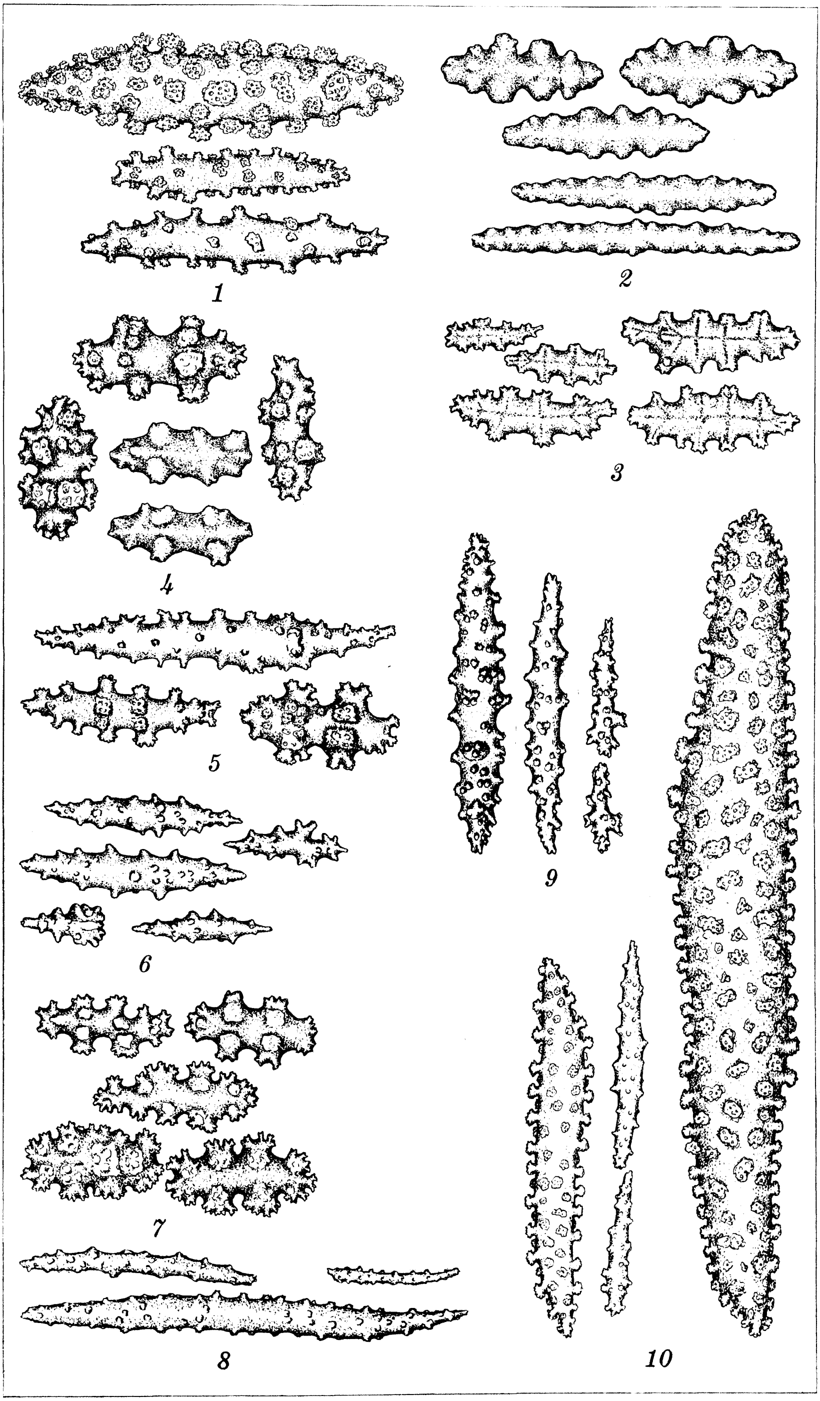
Sclerites from various species of the genera *Lemnalia* and *Paralemnalia* × 100; *a*, from tentacles; *b*, from polyp body; *c*, from stalk cœnenchyma; *d*, from stalk cortex.

FIG. 1. *Lemnalia bourni* Light MS.
2. *Lemnalia bantayensis* Light MS.
3. *Lemnalia philippinensis* (May).
4. *Lemnalia scasa* sp. nov.
5. *Lemnalia zimmeri* sp. nov.
6. *Lemnalia faustinoi* sp. nov.
7. *Lemnalia laevis* Thomson and Dean.
8. *Lemnalia grandispina* sp. nov.
9. *Paralemnalia thyrsoides* (Ehrenberg).

PLATE 5

Diagrams showing the polyp armature of various species of *Dendronephthya*.

FIG. 1. *Dendronephthya guggenheimi* sp. nov.
2. *Dendronephthya moseri* sp. nov.
3. *Dendronephthya gigantea* (Verrill).
4. *Dendronephthya spinifera* (Holm).
5. *Dendronephthya roemeri* Kükenthal.
6. *Dendronephthya aculeata* Kükenthal.
7. *Dendronephthya hicksoni* (Kükenthal).
8. *Dendronephthya griffini* sp. nov.
9. *Dendronephthya microspiculata* (Pütter).
10. *Dendronephthya radiata* Kükenthal.
11. *Dendronephthya pütteri* Kükenthal.
12. *Dendronephthya cervicornis* (Wright and Studer).
13. *Dendronephthya gracillama* Kükenthal.
14. *Dendronephthya flammea* Sherriffs.
15. *Dendronephthya repens* Kükenthal.
16. *Dendronephthya manyanensis* sp. nov.
17. *Dendronephthya florida* (Esper).
18. *Dendronephthya brevirama* (Burchardt).
19. *Dendronephthya malaya* sp. nov.
20. *Dendronephthya rubra* (May).



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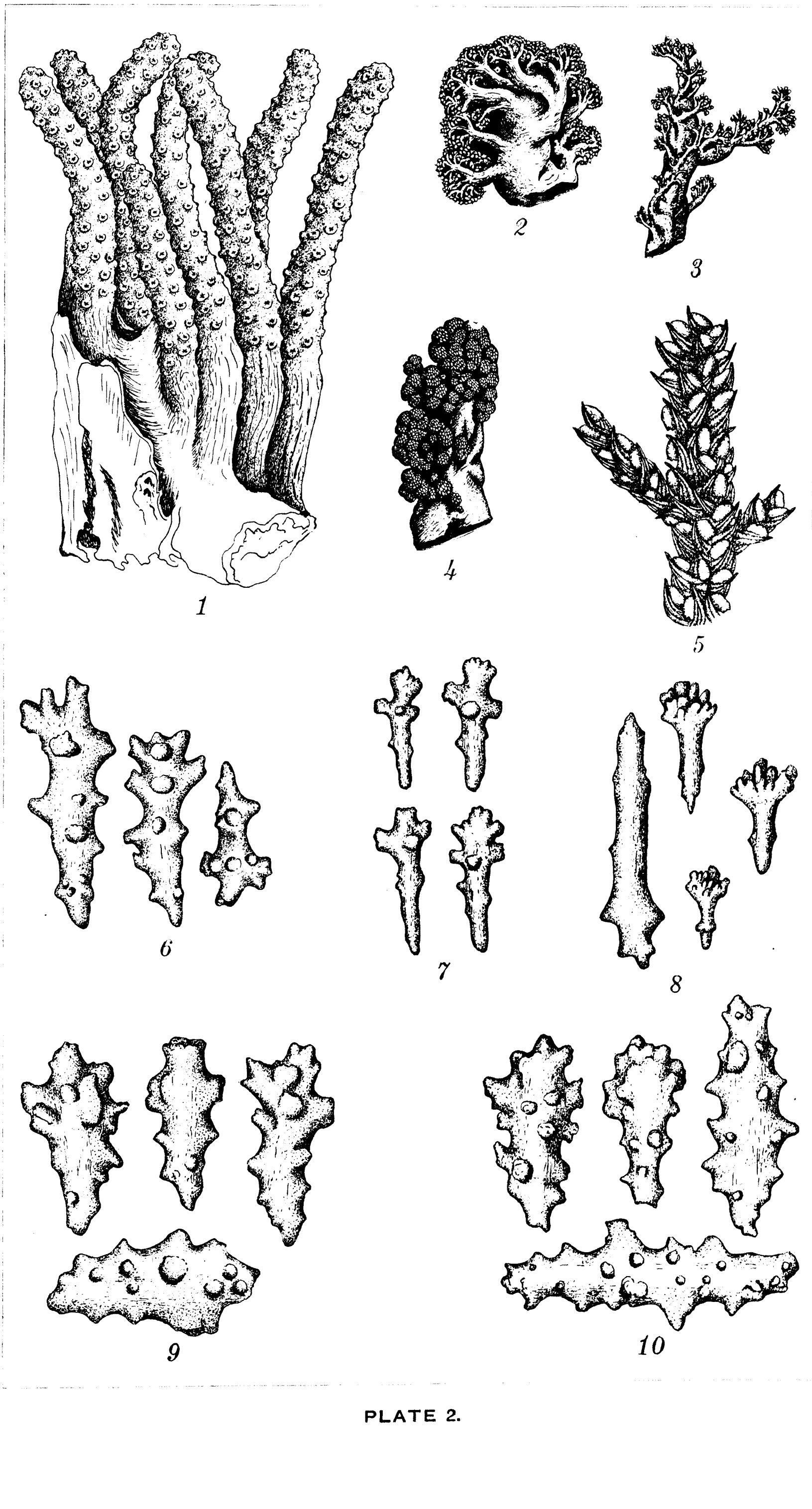

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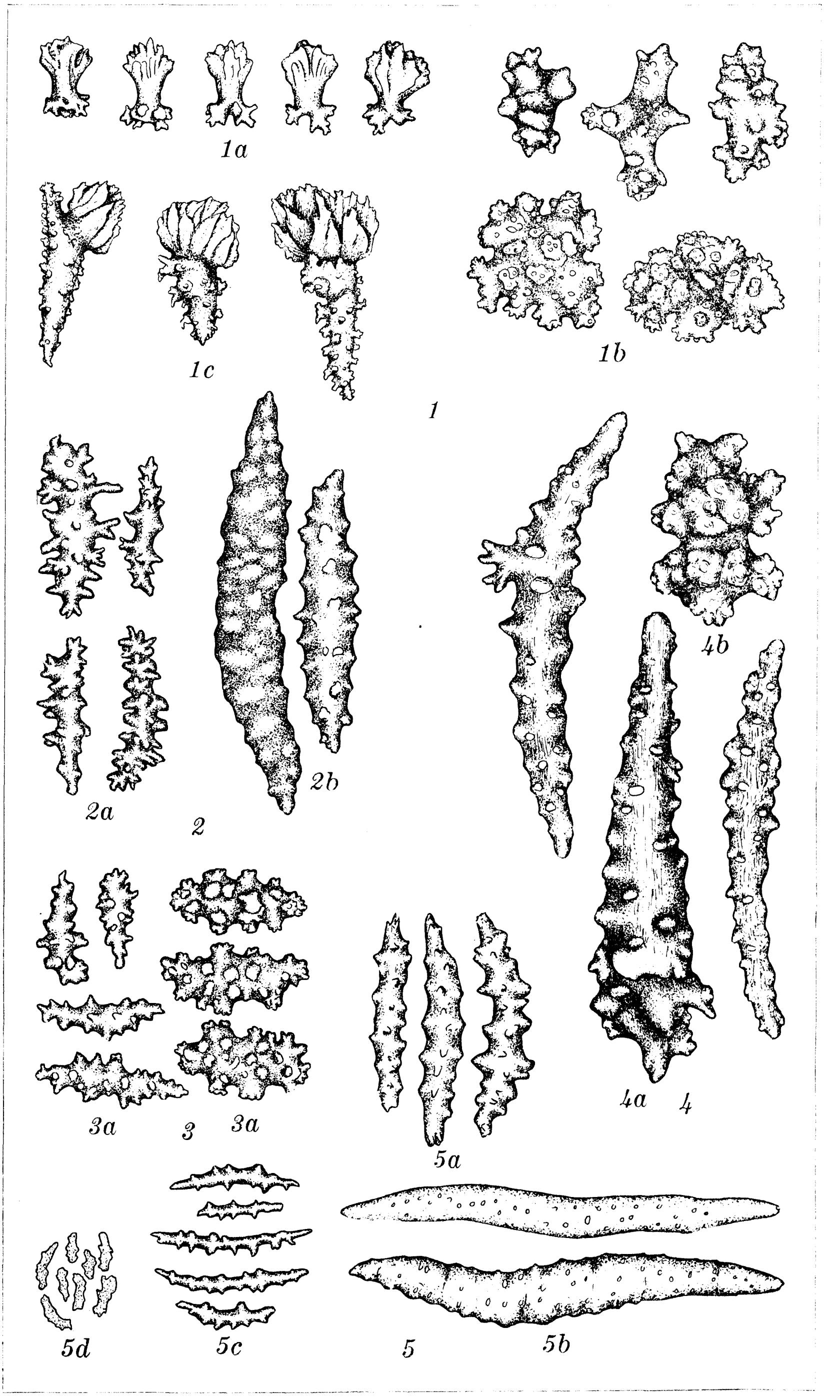

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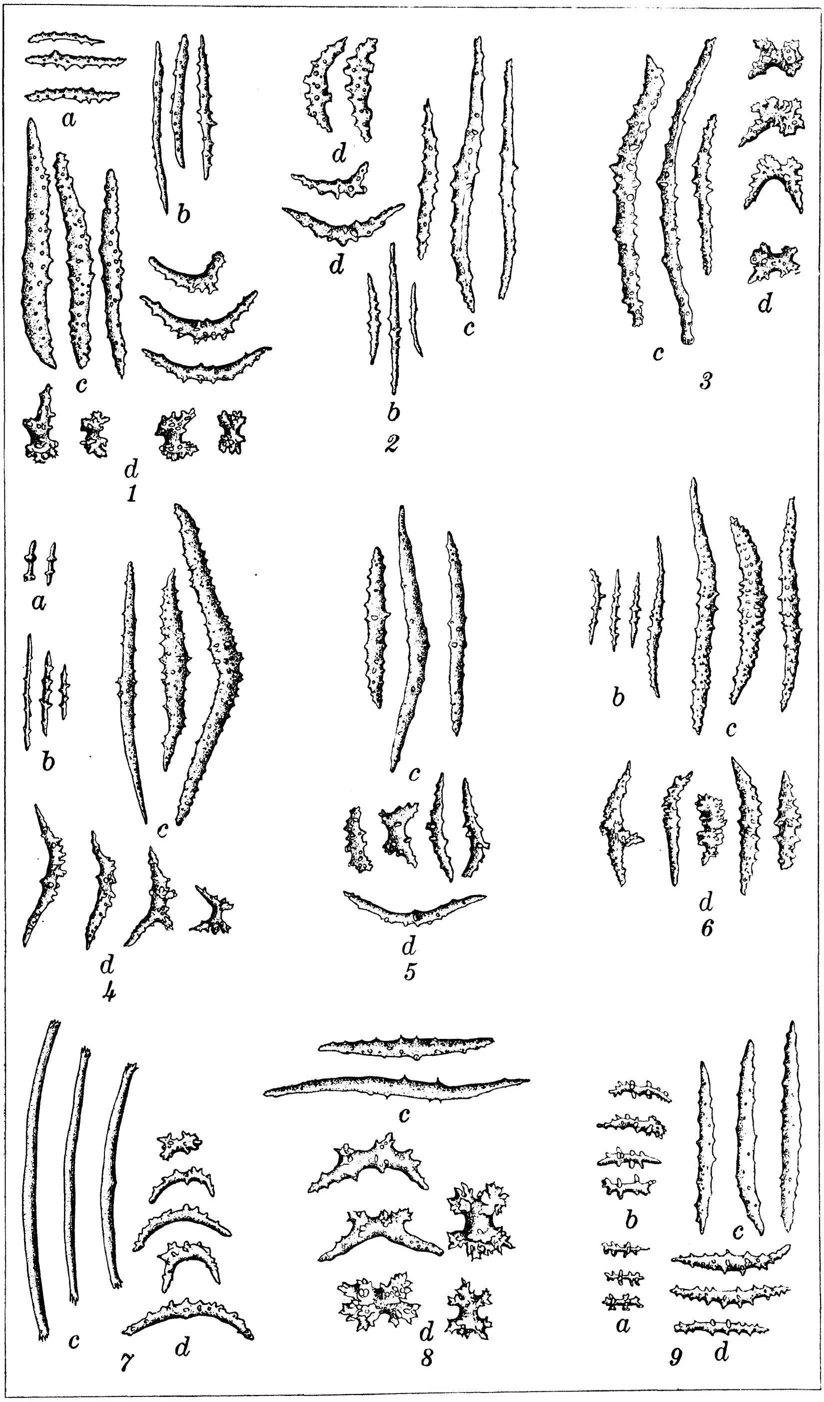

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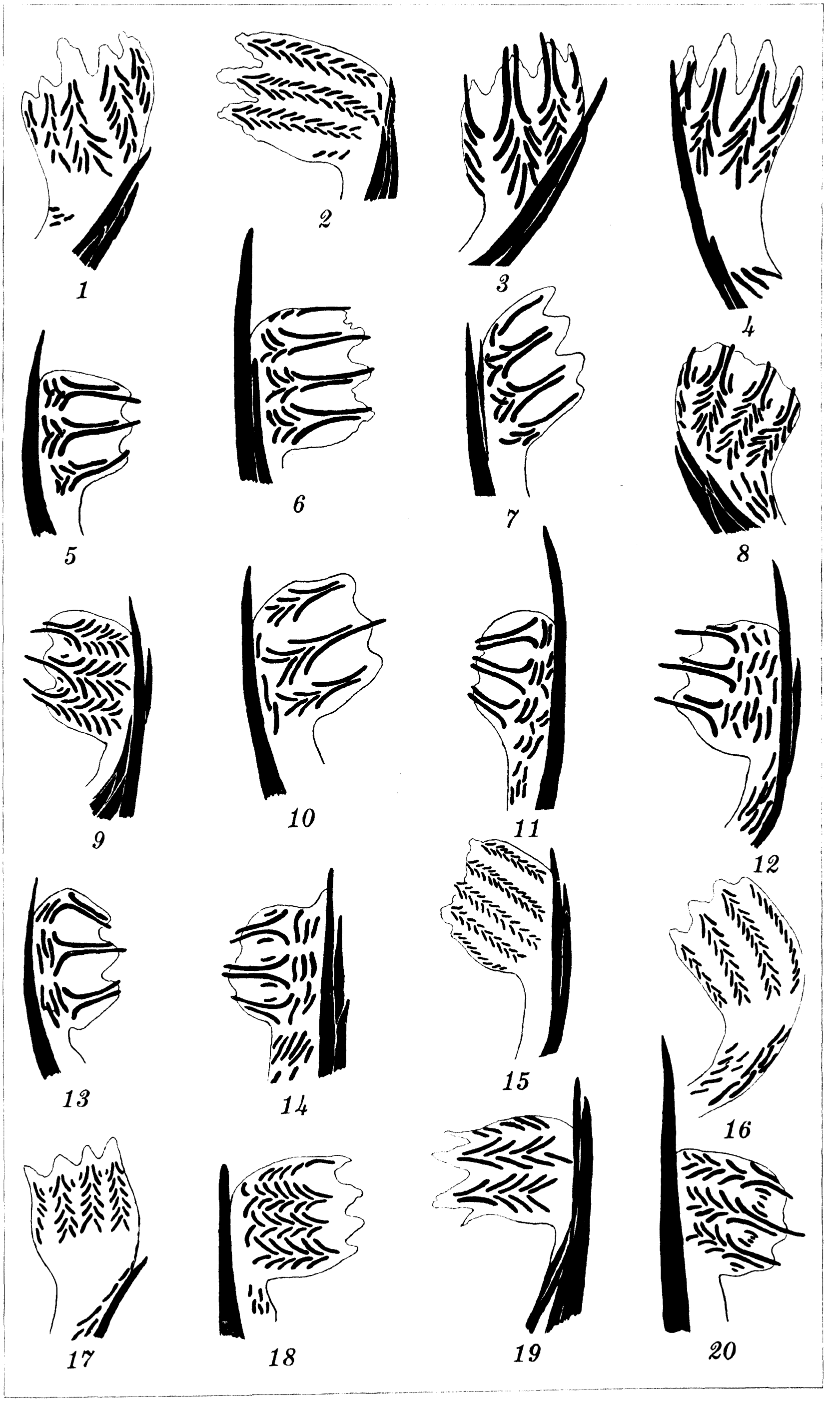

PLATE 5.

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